Water Resource Report 45
1979

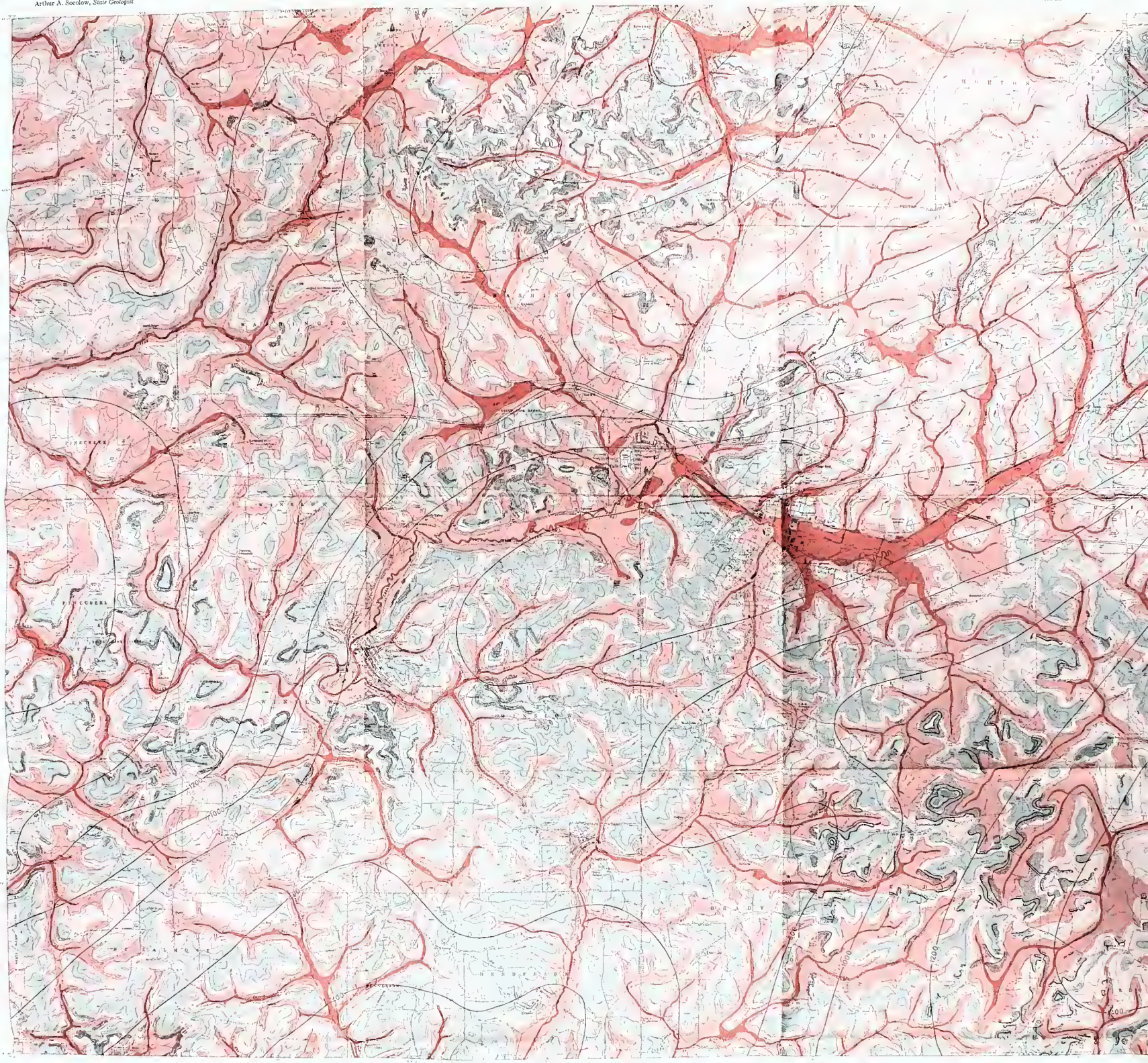
GROUNDWATER RESOURCES OF THE DUBOIS AREA, CLEARFIELD AND JEFFERSON COUNTIES, PENNSYLVANIA

Evan T. Shuster

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
BUREAU OF
TOPOGRAPHIC AND GEOLOGIC SURVEY
Arthur A. Socolow, State Geologist

TOPOGRAPHIC AND GEOLOGIC SURVEY
Arthur A. Socolow, *State Geologist*

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES



Base map from U. S. Geological Survey
Hazen, Falls Creek, Reynoldsville, Dubois, Sabula, Penfield, Luthersburg, and Elliott Park 7-1/2 minute quadrangles.

MAP SHOWING DEPTH TO THE WATER TABLE AND TO THE TOP OF S
IN THE DUBOIS AREA, JEFFERSON, CLEARFIELD, AND ELK COUNTIES, PE

BY

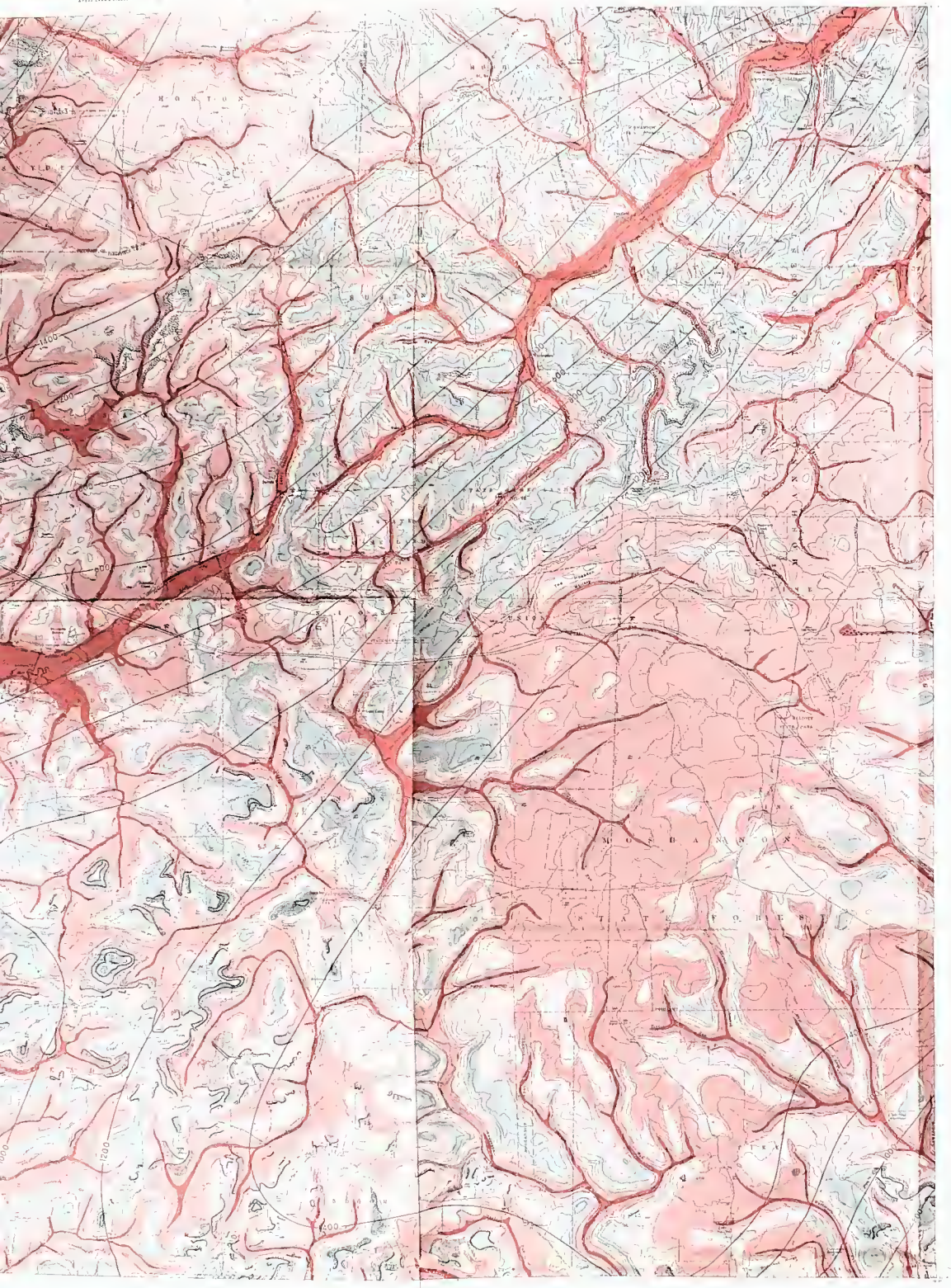
EVAN T. SHUSTER

1979

APPROXIMATE MEAN DECLINATION 13°E

SCALE 1:48,000

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL



John G. Kuchinski, Albert E. VanDilen, and Lajos J. Balogh, Cartographers

BLE AND TO THE TOP OF SALT WATER
ELD, AND ELK COUNTIES, PENNSYLVANIA

HUSTER

EXPLANATION

MEDIAN DEPTH (FEET)	RANGE OF THE MAJORITY OF WATER LEVELS BELOW LAND SURFACE (FEET)	DESCRIPTION OF SETTINGS
2-1/2	Flowing wells to 9	This category of water levels is generally found along valley bottoms that have permanent streams but lack floodplains. Flowing wells are common near the axes of major synclines.
15	10 to 24	These are the water levels in wells located on major floodplains, the lower slopes of deep valleys, broad, gently sloping land surfaces, and plateau areas. Flowing wells may occasionally occur in these areas; springs are common. Where the bedrock dips into the hill the water levels average 4 feet lower than where the dip is out of the hill.
40	25 to 54	These water levels are found beneath fairly steep slopes, especially the middle and upper slopes of valleys. *Perched water conditions and minor springs* and seeps are occasionally found in these areas. The depth to water is 10 to 15 feet greater on slopes where the bedrock dips into the hill than on slopes where the dip is out of the hill and toward the adjacent valley.
73	55 to 120	These depths to water are found under isolated hilltops and other high areas where recharge to the groundwater is limited. These depths are common in areas where deep mining has taken place. Wells may occasionally encounter perched water-bearing zones, but the amount of water available from these is usually limited.

SYMBOLS

1200

Elevation of the top of salt water

In feet above mean sea level; contour interval 200 feet. Depth to salt water for a specific site can be determined by subtracting this number from the surface elevation.

DEPTH TO WATER TABLE

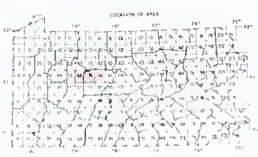
The water table is defined as the surface below which essentially all of the bedrock openings are saturated with groundwater. Above the water table both air and water may be found in these bedrock openings. It is the portion of a well below the water table that provides the water for well use.

The geology of the DuBois area is characterized by alternating layers of different types of rock which vary considerably in their ability to transmit water. A rock layer that impedes the downward movement of groundwater, such as shale, can cause a temporary mounding of groundwater above it. These unstable mounds of water are called "perched water zones," and are usually seasonal and of small extent. Thus they are almost always incapable of supplying adequate amounts of water for even household use. The "Depth to Water Table" map does not reflect the location of the top of any "perched water zones."

The elevation of the water table in the DuBois area generally *follows the topography. This means that the water table is at a higher* elevation beneath hills and other high areas than in the adjacent valleys. The hilly topography, the density of wells, and the nature of the bedrock do not allow for an accurate determination of the water-table elevation at all points on the map. Instead, statistical estimates of the depth to water in different topographic settings were made based on measured water levels within these settings. The topographic settings used were valley bottoms, lower slopes, upper slopes, isolated hilltops, and plateau areas. The latter are broad, fairly flat surfaces as are found around S. B. Elliott State Park. Median (50 percent of the measured depths to water are greater and 50 percent of the measured values are less) and range of the majority of water levels are given for each topographic setting. Because of a similarity in water levels, some of the topographic settings were combined into one map unit.

SALT WATER

In the sedimentary rock sequence of the DuBois area, salt water underlies the fresh water. The depth of the salt water below the ground surface varies from about 600 feet to 1,100 feet. The regional factors influencing the depth to salt water in the folded rocks of the DuBois area are the geologic structure and the topography. This deep salt water is probably connate water (water that was entrapped with the original sediments as they were deposited). Connate water is very highly mineralized, reflecting the saltiness of the original sea water and the millions of years this water has been in contact with the sediment. The contours represent elevations of the top of the saltwater mass in feet above mean sea level; the contour interval is 200 feet. The map locations were obtained primarily from drillers' logs for gas wells. Data used were the reports on the shallowest salt water encountered. To determine the approximate depth to salt water at a given location, obtain the land surface elevation from the topographic map contours and subtract the elevation of the top of the saltwater zone; this difference is the depth to salt water.



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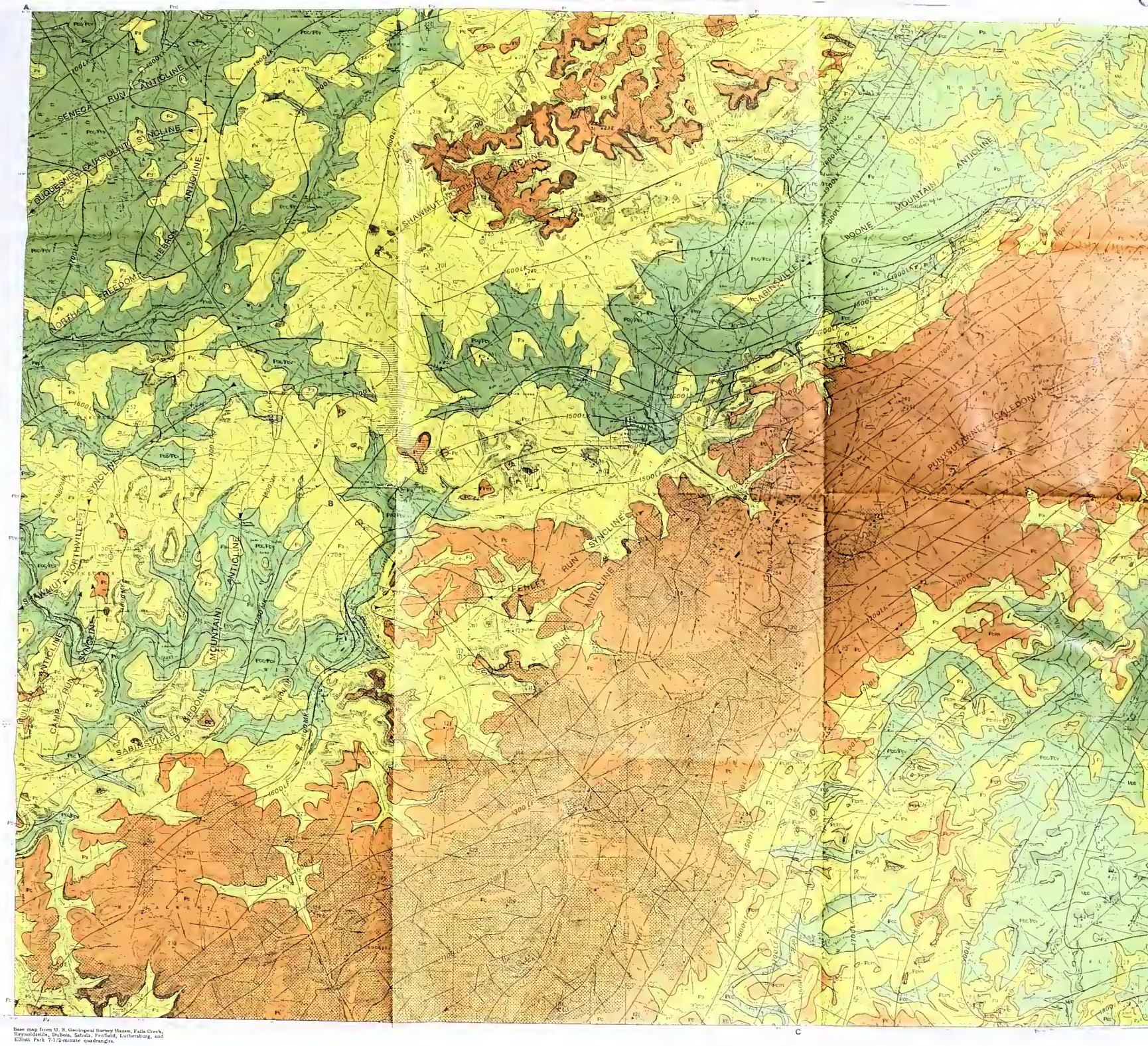

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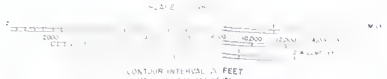
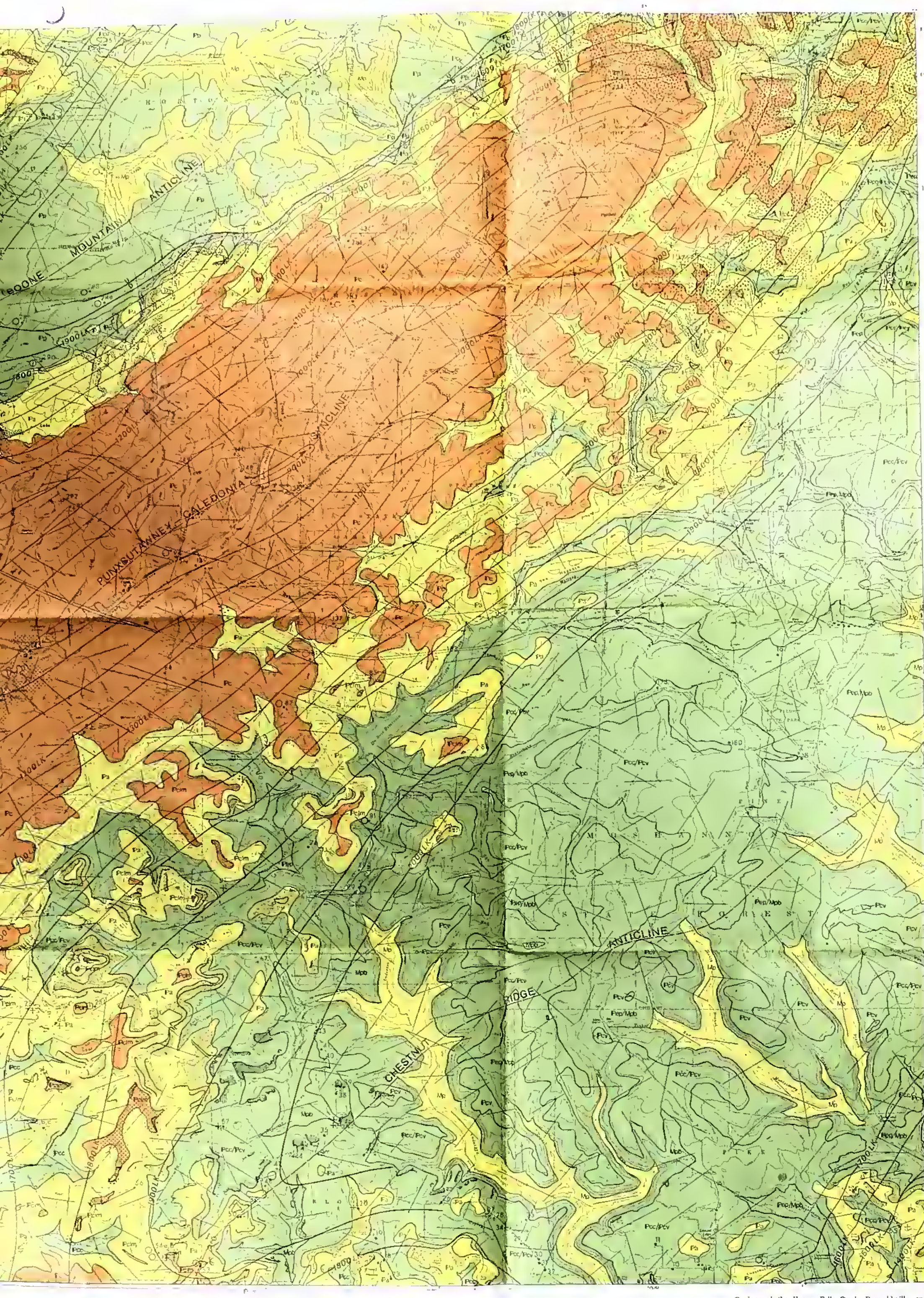
MAP SHOWING GROUNDWATER YIELDS AND RELATED FEATURES IN THE DU
JEFFERSON, CLEARFIELD, AND ELK COUNTIES, PENNSYLVANIA

BY EVAN T. SHUSTER

1979

APPROXIMATE MEAN DECLINATION, 1971





Geology of the Hazen, Falls Creek, Reynoldsville, and DuBois quadrangles by A. D. Glover and W. A. Bragonier (Pa. Geol. Survey, 4th ser., Atlas 64, 1978); geology of the Sabula and Penfield quadrangles by T. M. Berg and A. D Glover (Pa. Geol. Survey, 4th ser., Atlas 74ab, 1976); geology of the Luthersburg and Elliott Park quadrangles by W. E. Edmunds and T. M. Berg (Pa. Geol. Survey, 4th ser., Atlas 74cd, 1971).

Albert E. VanOlden, Virginia M. Milewski, and Lajos J. Balogh, Cartographers.

LATED FEATURES IN THE DUBOIS AREA,
K COUNTIES, PENNSYLVANIA
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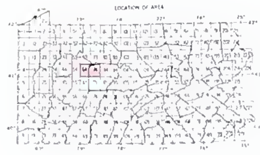


GROUNDWATER RESOURCES OF THE DUBOIS AREA, CLEARFIELD AND JEFFERSON COUNTIES, PENNSYLVANIA

by
Evan T. Shuster

INTRODUCTION

The purpose of this study is to determine the quantitative and qualitative aquifer characteristics of the near-surface geologic units. Because the DuBois area is expected to undergo significant growth in the near future, the relative potential of these units as sources of potable groundwater is becoming increasingly important.

The project area covers eight 7-1/2-minute topographic quadrangles: the Hazen, Falls Creek, Reynoldsville, DuBois, Sabula, Penfield, Luthersburg, and Elliott Park quadrangles. The area includes parts of Clearfield and Jefferson Counties and a very small portion of Horton Township in Elk County. In Clearfield County the townships covered all or in part are Huston, Sandy, Union, Pine, Brady, Bloom, and Pike, as well as the Boroughs of DuBois and Troutville. In Jefferson County the study included all or part of Warsaw, Snyder, Washington, Pinecreek, Winslow, McCalmont, and Henderson Townships and the Boroughs of Brockway, Falls Creek, Reynoldsville, and Sykesville.

The following individuals and agencies aided in the completion of this study: Harry Koester, George Schiner, and David O'Hara of the Water Resources Division of the U.S. Geological Survey provided groundwater information and equipment; geologists Albert Glover, William Edmunds, William Bragonier, Thomas Berg, and Alan Geyer of the Bureau of Topographic and Geologic Survey supplied much geologic advice; summer assistants Kenneth Patteson, John C. Hempel, and Linda Main aided with much of the field work; several well drillers in the DuBois area and Moody and Associates, Inc., of Meadville, Pennsylvania, supplied well locations and other hydrologic information.

WELL YIELDS

The principal rock types in the DuBois area are sandstone and conglomerate, shale, clay, and siltstone. Coal and limestone are also present, but occur only in a very small portion of the near-surface area. These rock types may be separated into two general hydrologic groupings based upon water-yielding characteristics. Sandstones and conglomerates will yield more water to wells than the fine-grained rocks such as shale, clay, and siltstone. The well yield values that were used to define these two groups were obtained from water well drillers' reports, published records, and pumping tests. Table 1 is a record of wells for the DuBois area, compiled from data on file in the Pennsylvania Geological Survey.

The well yield values were mathematically converted to indicate the yield, in gallons per minute, of each foot of rock thickness providing water to the well. The complicating effects of well construction and variable pumping rates are thus minimized. Because the overriding hydrologic consideration is the presence of sandstone, each of the geologic formations was evaluated according to the percentage of sandstone within that formation. Hydrogeologic units were determined by grouping hydrologically similar geologic formations. These have been shown on the map, and the hydrologic characteristics are given in the map explanation.

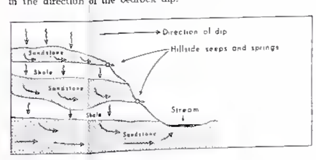
The water that bedrock supplies to water wells comes from two general types of sites within the rock mass. The most common type is the space that is found between the individual grains that make up the rock. These are called pore spaces. The usefulness of pore spaces from a hydrologic point of view is dependent on their size and the degree of interconnection between the pores, and is called the effective porosity. For sandstones in the DuBois area this will range from 3 to 14 percent of the total rock volume. For shales and other fine grained rocks the range is more like 0.5 to 5 percent. Pore spaces in the fine-grained rocks such as shale are exceedingly small. The water contained in them is difficult to remove.

The other type of site within the bedrock that provides water to wells is the area where the fractures and partings occur. These features are found in all types of rock throughout the rock mass. Fractures tend to be more open near the surface and become tighter with depth because of the pressure of the overlying rock. Sandstones are fairly brittle rocks; therefore they permit extensive and well-defined fractures to form. The fractures in shales and claystones, on the other hand, are often smaller, tighter, and less extensive because of the plastic nature of these rocks.

STRUCTURE

The geologic structure of the DuBois area is shown by the structure contour lines, which are lines of equal elevation of selected key rock layers (or beds). The structure contour lines define the topography of the surface of these beds. In most instances in western Pennsylvania it has been observed that the overlying and underlying rock has the same general orientation. The key beds used to determine the structure are the base of the Lower Kittanning no. 3 or "B_3" coal, which was used for most of the area; the base of the Middle Kittanning or "C" coal; and the base of the Lower Freeport or "D" coal. The Middle Kittanning coal is located an average of 60 feet above the Lower Kittanning coal.

Geologic structure influences the directions and rates of groundwater flow. The typical pattern of groundwater flow consists of movement downward and outward from the high elevations (hilltop and plateau areas), and upward and inward toward the stream valleys. This flow occurs more readily when the flow direction is parallel to the bedrock dip than when the flow direction is in opposition to the dip. Thus the major component of flow is generally in the direction of the bedrock dip.



FRACTURE TRACES

Fracturing in bedrock plays a major role in the local movement and storage of groundwater. In brittle rocks such as sandstone, fractures are usually well defined, extensive vertically and laterally, and open. In the more plastic rocks, such as shale and claystone, the fractures are smaller and tighter. Unfortunately, fractures may be the only effective source of water from shales; the pore spaces are too small to be hydrologically beneficial.

The fractures in bedrock result from the natural stresses in the earth's crust. Fractures can be seen in almost every outcrop or rock exposure; however, the density of fractures is not everywhere the same. There are long, usually straight, narrow zones where fracturing is more intense than in the surrounding rock. These zones may be only a few tens of feet wide. They can often be seen on aerial photographs as narrow lines of tonal change in the soil, as aligned stream segments, or as straight, narrow depressions in the land's surface. These surface expressions, which are called *fracture traces*, are thought to result from the increased susceptibility that fractured rock has to the weathering processes.

The major fracture traces in the DuBois area were mapped on aerial photographs and transposed to the map. Wells drilled on fracture traces may yield more water than similar wells drilled in the adjacent rock mass. The intersections of fracture traces may provide even more water to the wells drilled on them. The fracturing associated with fracture zones is vertical or nearly so and may extend to considerable depths. Fracture traces also may represent roof weakness in the deep-mine areas shown on the map.

DEEP MINES

In areas where deep mining of coals has taken place, the structure contours will help to determine the direction of mine-drainage flows and, when combined with the topographic contours on the map, will help locate mine-drainage discharge points. The deep-mine areas are shown on the map. These mined-out areas often affect the quality of the groundwater and the well-yield characteristics from the bedrock overlying the mines. Vertical fractures, some of which are naturally occurring and some of which result from roof collapse in the abandoned mines, drain off the water from the overlying rock mass. Wells that do not reach below the mines will tend to have irregular water levels and well yields. Bodies of groundwater overlying unflooded mines are, therefore, unreliable sources for wells. Once the mines are flooded it is possible for the water to return to its pre-mine levels. However, a return to pre-mining conditions cannot be guaranteed. In addition to the acid mine water that normally occurs in the mines, it is also possible for other pollutants to move unimpeded through the mines, making the water even more objectionable. The map does not show all of the mine entrances that may exist or the full extent of the mined-out areas.

GROUNDWATER QUALITY

Groundwater quality is a major problem in the DuBois area. The most troublesome constituents and properties are iron, sulfate, and total dissolved solids. Bacterial contamination is, for the most part, a localized problem affecting only individual wells.

Plate 1 shows the location of wells that were sampled for water-quality determinates. Those wells shown producing water of good to fair quality may have water that is slightly hard. Wells shown producing water of poor to fair quality have water that is high in iron, very hard, and/or high in total dissolved solids. A few analyses indicated moderately poor quality; the iron concentration is usually acceptable but the hardness is high. Table 2 lists chemical analyses for selected wells in the report area.

Shallow, hand-dug wells and springs that discharge from the upland areas usually produce water of good to excellent quality. Most of this water comes from sandstones that have been flushed of most of their soluble minerals by infiltrating precipitation. Water produced from shales, or sandstones overlain by shales, will tend to be more mineralized. The amount of iron or other dissolved ions depends on the form and concentration of these in the bedrock—a highly variable condition. Over much of the area good-quality water is obtained near the surface, and the deeper waters are high in iron and hardness. In some places, however, shallow zones of poor water may be cased off and better water obtained at greater depths.

All of the rock units used as aquifers in the DuBois area are known to have occurrences of both poor- and good-quality water. Some units are notorious for producing water of poor quality, such as the Kittanning and Homewood sandstones. Southwest of DuBois, deep mining may create local problems. Strip mines may have an adverse effect on the quality of water in wells located close to the stripping.

EXPLANATION

GEOLOGIC UNIT	GENERAL CHARACTER OF THE ROCK	DOMESTIC WELLS	PUBLIC AND INDUSTRIAL WELLS	WATER QUALITY
		ESTIMATED MEDIAN YIELD, IN GALLONS PER MINUTE, AND RANGE OF YIELDS		
Elliott Park Formation/ Burgoon Sandstone, or Pottsville Group (Pep/Mpb or Pp)	Elliott Park Formation/Burgoon Sandstone: Principally medium-grained sandstone, but also contains some shale, claystone, and coal. Average thickness is 245 feet. Pottsville Group: Principally medium- to coarse-grained sandstone, includes very coarse, quartzose conglomerate in lower 75 feet. Also includes some shale, discontinuous coal, and claystone. Average thickness is 150 feet.	50 15-100	150 50-400+	Fifty-five percent of the wells are reported to produce water of good quality. Generally the shallow wells produce water of fairly good quality; the deep wells that pass through overlying geologic units tend to produce water having a somewhat poorer quality as a result of increased iron content.
Clearfield Creek/ Curwensville Formations (Pcc/Pcv)	Sandstone, shale, and coal are the major rock types. The average thickness is 125 feet.	20 7-60	100 30-300+	Eighty percent of the wells are reported to produce water having a high iron content.
Lower Mahoning [illegible]	This unit often is a thick productive [illegible]	5 [illegible]	87 20-200	Sixty percent of the wells produce water of good quality.
[illegible] Sandstone (Mp)	[illegible] anticline. Average thickness of exposed part of unit is 360 feet.			
Allegheny Group excluding the Clearfield Creek Formation (Pa)	Highly variable rock types which change character with depth and lateral distance, contains shale, sandstone, siltstone, claystone, coal, and minor limestone. It is seldom necessary to drill deeper than 50 feet to hit a 5- to 15-foot sandstone. The major coal-mining activities are in this unit. The average thickness is 210 feet.	5 2-40	25 28-150	Sixty-seven percent of the wells in this unit are reported to produce water of good quality. Mining activities often cause a deterioration of the quality.

Table 2. *Chemical Analyses of Groundwater*

[Results are in milligrams per liter unless otherwise indicated.]

Well number	Date of collection	Total iron (Fe)	Total manganese (Mn)	Calcium (Ca)	Sulfate (SO_4)	Chloride (Cl)	Hardness (ppm)
CLEARFIELD COUNTY							
Cf 62a	7/73	6	–	–	<20	–	34.2
242	8/75	8	–	–	<20	–	17
281	9/68	4.6	–	–	124	3	194
282	7/69	.1	–	–	22	25	202
283	7/69	1.6	–	–	14	2	130
284	1/75	.21	–	–	–	–	85.5
286	3/75	14	–	–	–	–	205
287	4/73	0	–	–	2.2	1.6	82
288	4/73	.01	–	–	1.4	6	12
289	4/73	1	–	–	2	2.4	65
290	4/73	1.2	–	–	18	1.8	110
292	4/73	[illegible]	–	–	220	2.2	200

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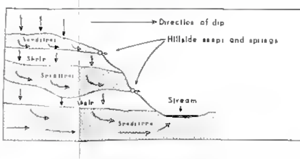

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Plate 3 shows the location of wells that were sampled for water-quality determination. Those wells shown producing water of good to fair quality may have water that is slightly hard. Wells shown producing water of poor to fair quality have water that is high in iron, very hard, and/or high in total dissolved solids. A few analyses indicated moderately poor quality; the iron concentration is usually acceptable but the hardness is high. Table 2 lists chemical analyses for selected wells in the report area.

Shallow hand-dug wells and springs that discharge from the upland areas usually produce water of good to excellent quality. Most of this water comes from sandstones that have been flushed of most of their soluble minerals by infiltrating precipitation. Water produced from shales, or sandstones overlain by shales, will tend to be more mineralized. The amount of iron or other dissolved ions depends on the form and concentration of these in the bedrock—a highly variable condition. Over much of the area good quality water is obtained near the surface, and the deeper waters are high in iron and hardness. In some places, however, shallow zones of poor water may be cased off and better water obtained at greater depths.

All of the rock units used as aquifers in the DuBois area are known to have occurrences of both poor and good quality water. Some units are notorious for producing water of poor quality, such as the Kittanning and Homewood sandstones. Southwest of DuBois, deep mining may create local problems. Strip mines may have an adverse effect on the quality of water in wells [illegible]

Table 1. *Record of Wells*

Well location: The number that is assigned to identify the well. It is prefixed by a two letter abbreviation of the county. The lat long is the coordinates, in degrees and minutes, of the southeast corner of a 1 minute quadrangle within which the well is located.

Aquifer name: Qal, alluvium; Pc, Conemaugh Group; Pclm, Lower Mahoning Sandstone; Pa, Allegheny Group; Pcc, Clearfield Creek Formation; Pp, Pottsville Group; Pcv, Curwensville Formation; Pep, Elliott Park Formation; Mpb, Burgoon Sandstone; Mp, Pocono Formation.

Aquifer composition: sh, shale; ss, sandstone.

Pumping data, yield: gpm, gallons per minute.

Well Number	Location Lat Long	Owner	Driller	Date completed	Aquifer Name	Aquifer Composition	Well depth (feet)	Casing Depth (feet)	Casing Diameter (inches)	Depth to water-bearing zone(s) (feet)	Static water level Depth below land surface (feet)	Static water level Date measured	Pumping data Yield (gpm)	Pumping data Drawdown (feet)	Pumping data Time (hrs)	pH
CLEARFIELD COUNTY																
Cl. 3	4100-7833	Robert Blackburn	F. W. Weber	1967	Mpb	–	143	–	–	138	–	–	–	–	–	–
5	4111-7830	Pa. Bureau of Parks	Pa. Drilling	1971	Mpb	ss	85	20.5	8	70, 74-85	Flowing	1975	160	10	24	–
6	4105-7832	Stone Palace	–	–	Mpb	–	88	–	0	–	8.0	7/73	–	–	–	–
7	4106-7841	Robert Williams	–	–	Mpb	–	86	–	–	–	36.5	7/73	–	–	–	–
8	4100-7831	Lewis Mandes	–	–	Mpb	–	100	–	0	–	78.1	7/73	–	–	–	–
9	4105-7831	Hobibaugh	–	–	–	–	–	–	–	–	13.9	7/73	–	–	–	–
10	4100-7833	Blair Passmore	John Pilar	1920	–	–	65	–	–	–	5.00	7/73	–	–	–	–
11	4100-7831	do.	–	–	–	–	–	–	–	–	7.1	7/73	–	–	–	–
12	4100-7833	William Lipper	F. W. Weber	1970	Pcv	ss	120	–	6	80	–	–	12-16	–	–	–
13	4100-7833	Sam Milliron	–	–	–	–	–	–	6	–	52.5	7/75	–	–	–	–
15	4100-7832	James Summers	Forsythe	1973	Pcv	–	105	–	0	–	58.5	7/73	–	–	–	–
16	4059-7831	C. D. Ross	F. W. Weber	1972	Mp	–	150	–	–	–	–	–	–	–	–	–
18	4100-7838	Bob Nalder	–	–	–	–	10	–	–	–	4.1	7/73	–	–	–	–
19	4100-7838	Ralph Thomas	–	–	Pcc	–	85	21	6	60	–	–	–	–	–	–
20	4100-7838	Albert Bloom	–	–	Pa	–	21	–	–	–	15.7	7/73	–	–	–	–
21	4101-7838	Merline Penton	–	–	Mpb	–	30(?)	–	–	–	15.3	7/73	–	–	–	–
22	4100-7838	J. C. Star	–	–	Pcs	–	20	–	–	–	.5	7/73	–	–	–	–
24	4100-7838		–	–	Pa	–	–		–	–	26.6	7/73	–	–	–	–
26	4100-7837	Thomas Allison	Forsythe	1969	Pcv	–	91		6	–	68.1	7/73	–	–	–	–
27	4100-7839	James Mahlon	–	–	–	–	22		–	–	16.2	7/73	–	–	–	–
28	4100-7839	Roy Mahlon	–	–	–	–	–		–	–	8.16	7/73	–	–	–	–
29	4100-7836	Hyre McCall	–	–	Pcc	–	18.0		–	–	11.16	7/73	–	–	–	–
30	4100-7836	Jerry McCullough	–	–	Pcs	–	22.2		–	–	9.75	7/73	–	–	–	–
31	4100-7835	John McKendrick	–	–	Pcc	–	24		–	–	14.4	7/73	–	–	–	–
32	4100-7835	Wayne Walburn	Forsythe	1963	Pcv	–	90		6	–	35	7/73	–	–	–	–
33	4100-7836	P. A. Clamm	–	–	Pcv	–	26		–	–	2.5	7/73	–	–	–	–
34	4100-7838	Richard Pressler	–	–	Pcc	–	–	–	–	–	34.7	7/73	–	–	–	–
35	4101-7839	Roger Patton	–	–	Pcv	–	–	–	–	–	12.3	7/73	–	–	–	–
36	4101-7838	George Anderson	–	–	Mpb	–	25	–	–	–	14.08	7/73	–	–	–	–
37	4101-7838	Victor Tubbs	–	–	Mpb	–	18	–	–	–	7.85	7/73	–	–	–	–
38	4102-7838		–	–	Pcv	–	–	–	–	–	20.0	7/73	–	–	–	–
39	4102-7838	Anderson Sportsman's Club	–	–	Pcv	–	–	–	–	–	9.76	7/73	–	–	–	–
40	4102-7839	Harold Miller	–	–	Mpb	–	18	–	–	–	10.25	7/73	–	–	–	–
41	4102-7839	Edward Gelnett	F. W. Weber	–	Mpb	–	33	7	0	–	.75	7/73	–	–	–	–
42	4102-7839	John Shubert	–	–	Mpb	–	10	–	–	–	2.9	7/73	–	–	–	–
43	4102-7839	do	–	–	Mpb	–	27	–	–	–	15.9	7/73	–	–	–	–
44	4101-7839	Mrs. Thomas Welder	–	–	Pcv	–	29	–	–	–	23.9	7/73	–	–	–	–
45	4101-7839	Luther Hatzfeld	–	–	Pcv	–	20	–	–	–	15.0	7/73	–	–	–	–
46	4101-7839	Mrs. Franklin	–	–	Pcv	–	22	–	–	–	14.25	7/73	–	–	–	–
47	4101-7839	Charles Haag	–	–	Pcc	–	–	–	–	–	6.9	7/73	–	–	–	–
48	4101-7840	Laxenblum	–	–	Pcs	–	–	–	–	–	3.0	7/73	–	–	–	–
49	4100-7840	Vern Farwerth	–	–	Pcs	–	–	–	–	–	6.4	7/73	–	–	–	–
50	4100-7840	–	–	–	Pa	–	–	–	–	–	14.75	7/73	–	–	–	–
51	4100-7840	–	–	–	Pa	–	–	–	–	–	33.5	7/73	–	–	–	–
53	4100-7841	John Kern	Forsythe	–	Pa	–	–	–	6	–	61.2	7/73	–	–	–	–
54a	4100-7841	Shaffer Estate	–	–	–	–	26	–	–	–	12.25	7/73	–	–	–	–
54b	4100-7841	do.	–	–	–	–	28	–	–	–	14.0	7/73	–	–	–	–
55	4100-7841	Leland Fred Shaffer	Forsythe	–	Pa	–	100	20	6	80	45.7	–	4	–	–	–
56	4101-7842	Robert Spencer	–	–	Pa	–	10	–	–	–	3.0	7/73	–	–	–	–
57	4101-7840	Charles Lee	Delp	–	Mpb	–	100	–	6	–	10.3	7/73	1	–	–	–
59a	4101-7843	Olan London	–	–	Pcc	–	100	32	6	–	40.00	–	–	–	–	–
59b	4101-7843	do.	–	–	–	–	81	20	6	–	35.00	–	–	–	–	–
59c	4101-7840	do.	–	–	–	–	25	–	–	–	13.4	7/73	–	–	–	–
60	4100-7844	–	–	–	Pa	–	24	–	–	–	12.5	7/73	–	–	–	–
62a	4101-7841	James Donahue	–	–	Pcc	–	28	–	–	–	17.0	7/73	–	–	–	–
62b	4101-7841	do	Lindemuth	1975	Pcc	–	42	18	6	–	14.1	7/73	21.4	5	.76	6.2
64	4100-7843	Don Witherlight	Forsythe	1963	Pa	–	85	–	–	–	51.8(?)	7/73	8-9	–	–	–
65	4100-7839	James Massy	do.	1972	Pcv	–	100	25	6	98	–	–	5	–	–	–
66	4100-7839	James Best	do.	1972	Pcv	–	80	25	6	78	–	–	5	–	–	–
67	4103-7840	Michael Blair	do.	–	Pcv	–	120	25	6	38	–	–	10-12	–	–	–
68	4103-7842	John Gray	–	–	Pa	–	14.3	–	–	–	7.8	7/73	–	–	–	–
70	4104-7842	–	Crytser	–	Pa	–	48	–	6	30	–	–	1	–	–	–
71	4104-7843	–	–	–	Pcc	–	14.5	–	–	–	4.5	7/73	–	–	–	–
72	4105-7844	Clyde Miller	Forsythe	–	Pc	–	86	32	6	34	27.8	7/73	20	–	–	–
73	4106-7844	C. A. Kessler	–	–	Pc	–	80	–	6	–	13.5	7/73	–	–	–	–
74	4105-7843	Mrs. Walter Dunlap	–	–	Pclm	–	24	–	–	–	4.1	7/73	–	–	–	–
76	4105-7839	Don Wayland	–	–	Pcc	–	9.5	–	–	–	6.4	7/73	–	–	–	–
78	4104-7839	Sunset Lake Campground	Union	–	–	–	120	–	6	40	–	–	–	–	–	–
79	4104-7838	Beers Music Center	Forsythe	–	Mpb	–	125	–	6	75	–	–	–	–	–	–
81	4105-7838	V. C. Shaffer	–	–	Pcv	–	–	–	–	–	6.6	7/73	–	–	–	–
83	4106-7842	Phyllis Sterling	–	–	Pclm	–	21	–	–	–	10.0	7/73	–	–	–	–
84	4100-7838	Chet Stiteler	–	–	Qal	–	16.9	–	–	–	4.3	7/73	–	–	–	–
85	4106-7838	Ronald Reed	–	–	Pclm	–	9.5	–	–	–	5.0	7/73	–	–	–	–
86	4106-7836	–	–	–	Pcv	–	160	–	6	–	131.8	7/73	–	–	–	–
87	4106-7839	Al Ornat and Son	Forsythe	1957	Pclm	–	56	–	6	–	28.0	7/73	–	–	–	–
88	4104-7841	Bernard Radaker	do.	1958	Pclm	–	135	30	–	18, 60, 120	–	–	7	–	–	–
89	4104-7838	George Postlethwart	–	–	Mpb	–	27.6	–	–	–	11.9	7/73	–	–	–	–
91	4104-7840	John Bainbridge	–	–	Pcc	–	25.7	–	–	–	14.0	7/73	–	–	–	–
92	4104-7844	Arthur Gerhart	–	–	–	–	14	–	–	–	7.2	7/73	–	–	–	–
93	4108-7842	–	–	–	–	–	79	–	6	–	35.6	8/73	–	–	–	–
94	4108-7841	Calvin Dixon	F. W. Weber	–	–	–	110(?)	15	6	–	21.6	8/73	–	–	–	–
98	4111-7832	Don Georgino	Forsythe	1969	–	–	168	30	6	–	–	–	–	–	–	–
101	4114-7831	Shawmut Mines	–	–	–	–	–	–	6	–	32.9	8/73	–	–	–	–
103	4101-7845	James Bonsall	–	–	–	–	18	–	–	–	14.8	8/73	–	–	–	–
104	4101-7846	Clair Bonsall	–	–	–	–	11	–	–	–	1.4	8/73	–	–	–	–
105	4100-7847	Robert Lee	–	–	Pc	–	21.8	–	–	–	10.1	8/73	–	–	–	–
106	4100-7848	William Mills	Dinges Bros	1970	–	–	222	3	6	76; 206	13.6	8/73	5-6	–	–	–
124	4106-7848	Tim Robertson	Forsythe	1972	–	–	200	170	6	180	–	–	10	–	–	–
127	4104-7848	Raymond Shaffer	–	–	Pc	–	–	–	6	–	39.2	8/73	–	–	–	–
128	4106-7847	Gary Pfulf	–	–	Pa	–	–	–	–	–	62.4	8/73	–	–	–	–
129	4104-7845	James Gray	–	–	Pc	–	17.4	–	–	–	9.6	8/73	–	–	–	–
130	4105-7845	John Fuller	F. W. Walter	1952	Pc	–	110	20	6	60; 94	–	–	–	–	–	–
132	4105-7845	Josephine Carlson	–	–	Pc	–	26	–	–	–	16.3	8/73	–	–	–	–
134	4112-7838	–	–	–	–	–	..	–	–	–	14.0	9/73	–	–	–	–
136	4109-7839	William Kennedy	–	–	Pa	–	85	–	6	–	50.8	9/73	–	–	–	–
137	4107-7838	Dale Weber	–	1970	Pa	–	225	27	6	190	–	–	15	–	–	–
138	4112-7840	R. L. Close	–	–	–	–	47.2	–	6	–	9.9	9/73	–	–	–	–
139	4108-7841	M. L. Stewart	–	–	Qal	–	13.0	–	–	–	6.0	9/73	–	–	–	–
140	4109-7840	Gordon Chillestes	Forsythe	1972	Pc	sh	235	23	6	60; 140; 215	–	–	72	–	–	–
142	4112-7839	George Cesnar	do.	–	–	–	40	20	6	20	–	–	–	–	–	–
143	4111-7838	Dale Foster	–	–	Pa	–	175	–	6	165	111.5	9/73	3-5	–	–	–
145	4107-7843	Henry Bailey	Crytser	–	Pc	–	64	–	–	–	15.1	9/73	–	–	–	–
147	4108-7841	Richard Kuntz	–	–	Pc	–	86	80(?)	6	–	22.6	9/73	–	–	–	–
148	4109-7840	Labana Burns	–	–	–	–	69(?)	–	6	–	30.5	9/73	–	–	–	–
149	4109-7841	Otto Edinger	–	–	Pa	–	18	–	–	–	13.7	9/73	–	–	–	–
151	4111-7841	Charles Young	–	–	Pa	–	–	–	–	–	13.9	9/73	–	–	–	–
152	4112-7839	John Molak	–	–	Pc	–	20(?)	–	–	–	16.2	9/73	–	–	–	–
161	4111-7839	Franklin Tyler, Jr.	Forsythe	1973	Pc	–	215	–	–	–	110.5	10/73	–	–	–	–
167	4107-7832	Pa. Bureau of Forestry	Crytser	1964	–	–	152	20	6	100; 150	10.2	8/73	40	–	–	–
169	4112-7831	Lady Jane Collieries Inc.	Delp	1972	–	–	606	25	10	168; 300	–	–	2	–	–	–
176	4111-7833	Devonian Gas & Oil Co.	–	–	–	–	149	–	–	–	112.2	9/73	–	–	–	–
178	4106-7833	Camp 9C-244	–	–	–	–	8	–	–	–	5.0	9/73	–	–	–	–
180	4106-7832	Twin Oaks Camp 9C-31	–	–	–	–	–	–	–	–	17.2	9/73	–	–	–	–
181	4107-7839	Emory Miller	Forsythe	–	–	–	150	–	–	–	63.4	9/73	–	–	–	–
183	4107-7837	–	–	–	–	–	–	–	–	–	8.6	9/73	–	–	–	–
211	4108-7845	Dr. W. Lundgren	Crytser	1966	Pa	ss	113	–	6	–	–	–	15	0	2	–
233	4111-7846	Mrs. Clark	Lindemuth	1973	Pcv	sh	106	24	6	50; 90	–	–	10	30	.5	–
234	4111-7846	Kruk Floors	Forsythe	1972	–	–	120	21	6	110	–	–	10	–	–	–
235	4111-7846	Gorham Bros.	do.	1972	–	ss	140	21	6	120	–	–	10	–	–	–
242	4101-7844	Hartzlell	–	–	Pcc	–	109	–	–	–	16.75	8/75	–	–	–	6.1
243	4114-7834	Dale Crawford	Crytser	1974	Pa	ss	62	14	6	50	–	–	20	0	2	–
244	4114-7834	Dennis Crawford	do.	1975	Pc	ss	51	15	6	40	–	–	20	0	2	–
263	4111-7838	Clyde Keller	Webber	–	Pa	–	150	–	–	–	111.0	10/73	–	–	–	–
264	4108-7846	Denlon Const.(?)	Crytser	1966	Pa	ss	295	35	8	105; 250	–	–	45	0	4	–
265	4114-7832	Pa. State Univ.	Brooks	1969	Pcc	–	125	55	8	80, 105	–	–	60	1.5	48	7.5
281	4103-7842	Luthersburg School	Tygar	1965	Pa	–	260	22	6	138; 154; 212; 260	78.75	9/65	11	1	1.25	6.9
282	4102-7846	Helvetia Water Co.	Forsythe	1961	Pa	ss	250	20	8	–	105	2/75	28	27	4	–
283	4102-7846	do.	–	1948	Pa	ss	187	50	6	–	38	5/64	23	18	4	–
284	4106-7845	Highland High School	Pa. Drilling	1975	Pa	ss	292	–	–	88; 125; 182	30	1/75	2	–	–	–
285	4112-7838	Pa. Core Hole #1	Harvey	1969	–	–	716	–	–	–	55	4/73	–	–	–	–
286	4103-7843	DuBois Area School	Pa. Drilling	1975	Pa	–	80	–	–	–	50.2	2/75	–	–	–	–
287	4111-7843	Treasure Lake	Layne	1970	Pep	–	360	31	10	36; 130, 159, 174	Flowing	11/70	305	102	48	–
288	4111-7842	do.	do.	1970	Pep	–	290	22	6	–	37.2	12/70	140	11(?)	12	–
289	4111-7842	do.	do.	1970	Mp	–	410	24	10	20; 98; 111; 245	20	12/70	250	56	48	–
290	4110-7843	do.	do.	1970	Mpb(?)	–	440	26	6	25, 41; 60; 202	15	9/70	200	–	12	–
291	4109-7842	do.	do.	1970	Pc	–	265	20	8	50; 65; 120	Flowing	8/70	80	27	48	–
292	4109-7843	do.	do.	1970	Pc	–	265	14	8	–	Flowing	8/70	132	50	48	–
ELK COUNTY																
Ek. 97	4114-7831	Bernice Washkow	–	–	–	–	–	–	–	–	14.76	8/73	–	–	–	–
155	4114-7843	Sam Siple	–	–	Pa	–	21	–	–	–	10.0	9/73	–	–	–	–
157	4113-7844	John Duttry	–	–	Pa	–	19	–	–	–	9.9	10/73	–	–	–	–
158a	4114-7842	Lorn Coleman	–	–	Pcc	–	55.5	–	–	–	5.0	10/73	–	–	–	–
158b	4114-7842	do.	–	–	Pp	–	72	–	–	–	13.3	10/73	–	–	–	–
177	4114-7838	Carolyn Hoover	–	–	–	–	106	–	–	–	–	–	1.5	15	1	–
203	4114-7842	Brockway Bor.	–	1969	Mp	–	120	–	–	72; 86; 98	–	–	500(?)	–	–	–
JEFFERSON COUNTY																
Je. 108	4102-7851	Jim Douthit	Forsythe	1970	Pc	–	160	–	–	–	122.2	8/73	–	–	–	–
109	4101-7850	Charles Kurtz	Dinger Bros.	1973	Pc	–	85	21	6	70	42.7	8/73	5	–	–	–
110	4100-7849	Gordon Knurr	–	–	Pc	–	125	25(?)	6	–	33.9	8/73	–	–	–	–
111	4101-7848	P. E. Syphrit	–	–	Pc	–	65(?)	–	–	–	32.2	8/73	–	–	–	–
112	4105-7851	Mike Maxim, Sr.	–	–	Pa	–	32	–	–	–	19.9	8/73	–	–	–	–
113	4104-7850	S. M. Lyles	–	–	–	–	25	–	–	–	5.0	8/73	–	–	–	–
114	4103-7850	John Wascovich	–	–	–	–	25	–	–	–	18.0	8/73	–	–	–	–
116	4101-7852	Leslie Piller	Morris Smith	1954	Pc	–	49	26	–	–	16.5	8/73	–	–	–	–
120	4105-7851	Mrs. Pearl Rea	–	–	–	–	–	–	–	–	5.9	8/73	–	–	–	–
121	4104-7851	Charles Fye	–	–	Pa	–	75	–	–	–	5.6	8/73	–	–	–	–
122	4105-7850	Paul Sylus	–	–	Pa	–	12.8	–	–	–	8.0	8/73	–	–	–	–
125	4105-7848	Clyde Hannah	–	–	Pa	–	16.8	–	–	–	4.6	8/73	–	–	–	–
126	4105-7848	Howard Adamson	–	–	Pa	–	37(?)	–	–	–	21.4	3/73	–	–	–	–
133	4107-7849	L. C. Tapper	Crytser	1965(?)	Pa	–	50	45	8	–	14.7	9/73	–	–	–	–
150	4113-7841	–	–	–	Pp	–	80	–	–	–	9.9	10/73	30	–	–	–
160a	4108-7850	H. W. Anthony	Forsythe	–	Pa	–	184	52	6	–	73.9	10/73	–	–	–	–
160b	4108-7850	do.	–	–	Pa	–	92	19	6	–	48.2	10/73	–	–	–	–
162	4108-7850	Space	–	–	Pa	–	14	–	–	–	10.2	10/73	–	–	–	–
163	4109-7851	Angelo Panall	–	–	Pcc	–	13	–	–	–	5.0	10/73	–	–	–	–
164	4109-7851	–	–	–	Pcc	–	47	–	–	–	17.0	10/73	–	–	–	–
165	4110-7850	Gerald Taft	–	–	–	–	45	–	–	–	11.6	10/73	–	–	–	–
185	4103-7852	John Biggie	–	–	–	–	90(?)	–	6	–	49.7	6/74	15(?)	–	–	–
186	4101-7853	Akens	–	–	–	–	80(?)	–	–	40	–	–	20	–	–	–
188	4103-7851	–	–	–	–	–	27	–	–	–	6.5	6/74	–	–	–	–
190	4102-7856	Robert Hallzenrater	Crytser	1973	–	–	175	–	–	170	–	–	10	–	–	–
191	4104-7854	Phyllis Roush	–	–	–	–	24	–	–	–	15.8	6/74	–	–	–	–
192	4103-7853	Harvey Delberry	Crytser	1974	–	–	150	20	6	100	96.0	6/74	15	–	–	–
193	4101-7854	George Surkala	do.	1969	Pa	–	177	27	6	157	–	–	30	–	–	–
194	4101-7854	–	do.	1969	–	–	190	–	6	60	109.2	4/74	15	–	–	–
195	4102-7852	H. L. Bulles	do.	1973	–	–	385	–	–	200; 385	228.7	6/74	15	–	–	–
196	4101-7857	Jim Hixson	–	–	–	–	40	–	–	35	–	–	10	–	–	–
197	4101-7855	Dave Snyder	Forsythe	1972	–	–	60	–	6	30	34.9	6/74	10	–	–	–
198	4101-7850	Thea Horner	–	1960	–	–	75	–	–	30; 75	–	–	10-15	–	–	–
200	4107-7858	J. F. Trautman	Hukey	1952	–	–	47	20	6	45	–	–	5	–	–	–
201	4104-7859	Paul Flynn	–	–	–	–	28	–	–	15	18.8	6/74	5-10	–	–	–
202	4104-7850	do.	–	–	–	–	85	–	6	40(?)	–	–	2	–	–	–
203	4101-7900	G. M. Rene	Dinger Bros.	1971	–	–	220	21	6	200	–	–	10	–	–	–
204	4101-7850	Arden Johles	–	–	–	–	40	21	[illegible]	30	28.2	6/74	–	–	–	–
205	4103-7858	Robert Uplinger	Dinger Bros.	1968	–	–	120	22	6	75, 116	–	–	3-4	–	–	–
206	4106-7853	B. Virian	–	–	–	–	45	20	6	15	–	–	5-10	–	–	–
209	4100-7859	L. Fisher	S & W Drilling	1972	–	–	130	130	6	40	–	–	90	–	–	7.6
210	4101-7856	Bob Wallman	Miller Pump	–	–	–	196	–	6	–	–	–	10	–	–	–
213	4113-7845	R. Mallery	Forsythe	1968	–	–	245	60	6	89; 245	–	–	5	–	–	–
217	4113-7850	Hiram Bundy	–	–	–	–	100	–	6	–	–	–	5-10	–	–	–
218	4113-7852	Rodger Lindemuth	Lindemuth	1971	–	–	18	21	6	12	–	–	10+	–	–	–
219	4114-7850	Robert Lindemuth	do.	–	–	–	25	25	6	14	–	–	10+	–	–	–
220	4114-7852	William Borsled	Crytser	–	–	–	50(?)	–	–	–	–	–	5+	–	–	–
222	4113-7847	Everall Gustafson	–	–	–	–	280	21	6	118, 140	–	–	5+	–	–	–
223	4113-7849	Sam Gallo	Lindemuth	1973	–	–	140	20	6	–	–	–	5-10	–	–	–
224	4112-7851	Mel Jamison	do.	1971	–	–	200+	21	–	–	–	–	5+	–	–	–
225	4111-7851	Todd Kalgren	Crytser	1968	–	–	75	20	–	–	–	–	15	–	–	7
226	4111-7840	Herb Stevenson	Forsythe	–	–	–	100+	–	6	–	–	–	10+	–	–	–
227	4113-7850	Mrs. Shafer	Crytser	1967	–	–	121	50	6	50	48.1	7/74	5-10	–	–	–
228	4112-7859	H. C. Boozer	Delp	1971	–	ss	110	27	6	–	–	–	5-10	–	–	6.7
229	4112-7859	A. Van Norman	Forsythe	1960	–	–	30	–	–	–	–	–	5-10	–	–	–
231	4114-7854	William Brosius	Delp	1971	–	–	52	20	6	10; 45	–	–	10	–	–	–
232	4113-7848	Sam Gallo	Lindemuth	1973	Pa	ss	140	20	6	125	–	–	10+	10	.5	–
236	4112-7847	Dick Smith	do.	1973	Pa	sh	80	30	6	70	–	–	7	10	.5	–
237	4112-7854	Dick Quinn	Delp	1973	–	–	55	22	8	–	–	–	10	–	–	–
238	4113-7852	Melvin Lindemuth	Lindemuth	1974	–	–	40	34	6	35	–	–	–	–	–	–
239	4110-7852	Kenneth Tudor	do.	1972	Pa	ss	40	22	6	28	–	–	5	–	–	–
246	4109-7857	Pa. Dept. of Transportation	Moody	1970	Mpb	ss	294	170	6	–	34.18	10/75	35	5.6	48	6.8
247	4107-7852	Harold Raybuck	Crytser	1975	Pcc	sh	70	14	6	60	–	–	8	30	2	–
248	4108-7856	Pa. Dept. of Transportation	Moody	1970	Pep	ss	295	85	6	79; 220; 250	–	–	35	5	48	6.6
249	4110-7850	John Tunsch	Crytser	1975	Pa	sh	50	28	6	34; 40	–	–	20	15	2	–
251	4109-7850	North Star Construction	do.	1975	Pa	sh	60	23	6	45	–	–	15	–	–	–
252	4108-7857	Robert Emery	Miller	1974	Pcc	ss	126	18	6	45	–	–	5	76	.5	–
254	4111-7858	Bill Ecler	Crytser	1975	Pcv	ss	102	14	6	90	58	10/75	40	0	4	–
255	4112-7857	Harold Lockwood	Lindemuth	1974	Pcc	ss	120	21	6	50, 100	–	–	10+	0	.5	–
256	4100-7849	Francis Collier	Crytser	1975	Pcc	ss	33	16	6	25	–	–	40	10	4	–
257	4109-7849	Kendall Perrin	do.	1973	Pcc	ss	30	15	6	25	–	–	30	0	3	–
258	4108-7858	Ray Hoger	do.	1973	Pcv	ss	138	25	6	130	–	–	20	0	2	–

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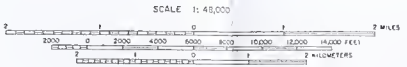
MAP SHOWING GROUNDWATER YIELDS AND RELATED FEATURES IN THE D
JEFFERSON, CLEARFIELD, AND ELK COUNTIES, PENNSYLVANIA

BY EVAN T. SHUSTER

1979

APPROXIMATE MEAN DECLINATION, 1971



CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

SYMBOLS

Contact
Includes approximately located and inferred contacts

Major fault
The relative movement of the fault is shown by the "U" and "D", the "U" side has moved up relative to the "D" side

Axis of anticline
Large arrow points in the direction of anticlinal plunge; small arrows indicate the direction in which the strata dip.

Axis of syncline
Large arrow points in the direction of synclinal plunge, small arrows indicate the direction in which the strata dip

Base of Lower Freeport coal —1500 LF—
Base of Middle Kittanning coal —1800 MK—
Base of Lower Kittanning no. 3 coal —1800 LK—

Structure contour line
Elevations above mean sea level Contour interval 100 feet

Strip mine

Fracture trace

14
Location of well
Number is keyed to Tables 1 and 2.

Fair to good, may be slightly hard ○
Poor to fair, high iron content is the major problem +
Iron content fairly low but water is hard ⓘ

Quality of water

In the Upper Freeport coal
In the Lower Freeport coal
In the Upper Kittanning coal
In the Middle Kittanning coal
In the Lower Kittanning coal
In the Brookville-Clarion coal

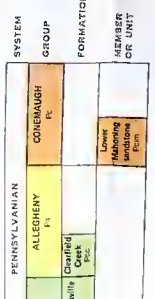
Area underlain by known deep mine

Active
Abandoned
Abandoned, location approximate
Drift entrance to a mine

Mine shaft

A GENERALIZED COLUMN OF THE ROCKS EXPOSED AT THE SURFACE

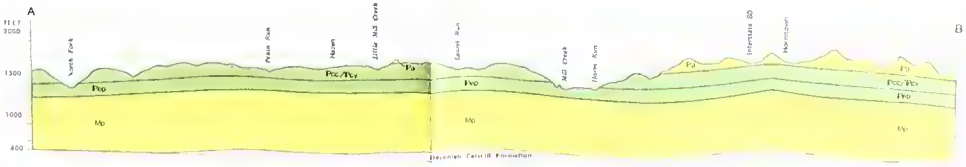
(Rock formations and groups are arranged from the oldest at the bottom to the youngest at the top.)

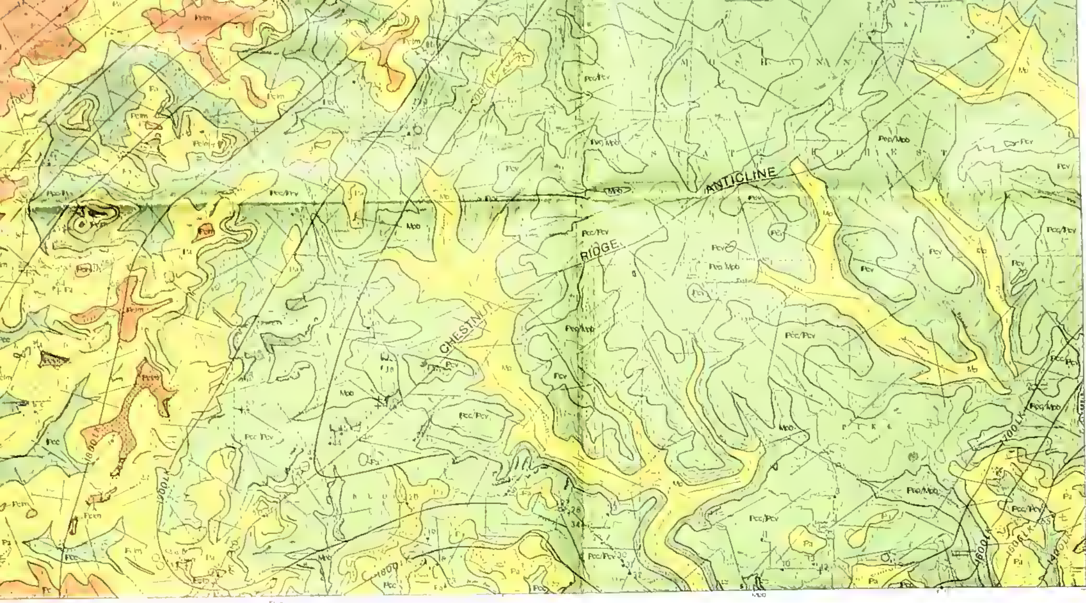


GEOLOGIC UNIT	GENERAL CHARACTE
Elliott Park Formation/ Burgoon Sandstone, or Pottsville Group (Pep/Mpb or Pp)	Elliott Park Formation/ Principally medium-grai also contains some shale, Average thickness is 24 Pottsville Group: Princ coarse-grained sandston coarse, quartzose congloi feet. Also includes some coal, and claystone. Aver feet.
Clearfield Creek/ Curwensville Formations (Pcc/Pcv)	Sandstone, shale, and coa types. The average thick
Lower Mahoning Sandstone (Pcm)	This unit often is a sandstone; there are some In places it may be fine a large amount of clay m an average thickness of
Conemaugh Group (Pc)	Mostly shale and siltstone a few fine-grained clayey s thin limestone and clay b thickness of the remainin in the area is about 630
Pocono Formation excluding the Burgoon Sandstone (Mp)	Mixed siltstone, shale, an claystone beds. Upper red well exposed southeast of anticline. Average thickne of unit is 360 feet.
Allegheny Group excluding the Clearfield Creek Formation (Pa)	Highly variable rock typ character with depth an contains shale, sandstone, coal, and minor limesto necessary to drill deeper t a 5- to 15-foot sandst coal-mining activities are average thickness is 210 f

CROSS SECTIONS

(Horizontal scale same as map scale, vertical exaggeration x 2)





Geology of the Hazen, Falls Creek, Reynoldsville, and DuBois quadrangles by A. D. Glover and W. A. Bragonier (Pa. Geol. Survey, 4th ser., Atlas 64, 1978), geology of the Sabula and Penfield quadrangles by T. M. Berg and A. D. Glover (Pa. Geol. Survey, 4th ser., Atlas 74ab, 1976), geology of the Luthersburg and Elliott Park quadrangles by W. E. Edmunds and T. M. Berg (Pa. Geol. Survey, 4th ser., Atlas 74cd, 1971).

Albert E. VanOlden, Virginia M. Milewski, and Lajos J. Balogh, Cartographers

...ATED FEATURES IN THE DUBOIS AREA,
... COUNTIES, PENNSYLVANIA

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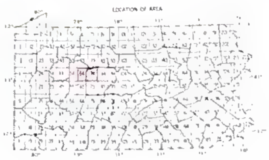
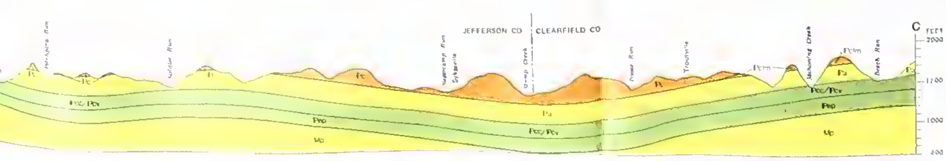


EXPLANATION

GEOLOGIC UNIT	GENERAL CHARACTER OF THE ROCK	DOMESTIC WELLS	PUBLIC AND INDUSTRIAL WELLS	WATER QUALITY
		ESTIMATED MEDIAN YIELD, IN GALLONS PER MINUTE AND RANGE OF YIELDS		
Elliott Park Formation/ Burgoon Sandstone, or Pottsville Group (Pep/Mpb or Pp)	Elliott Park Formation/Burgoon Sandstone: Principally medium-grained sandstone, but also contains some shale, claystone, and coal. Average thickness is 245 feet. Pottsville Group: Principally medium- to coarse-grained sandstone; includes very coarse, quartzose conglomerate in lower 75 feet. Also includes some shale, discontinuous coal, and claystone. Average thickness is 150 feet.	50 15-100	150 50-400+	Fifty-five percent of the wells are reported to produce water of good quality. Generally the shallow wells produce water of fairly good quality; the deep wells that pass through overlying geologic units tend to produce water having a somewhat poorer quality as a result of increased iron content.
Clearfield Creek/ Curwensville Formations (Pcc/Pcv)	Sandstone, shale, and coal are the major rock types. The average thickness is 125 feet.	20 7-60	100 30-300+	Eighty percent of the wells are reported to produce water having a high iron content.
Lower Mahoning Sandstone (Pclm)	This unit often is a thick productive sandstone; there are some clay and shale beds. In places it may be fine grained and contain a large amount of clay matrix. The unit has an average thickness of 60 feet.	5 2-90	87 20-200	Sixty percent of the wells produce water of good quality.
Conemaugh Group (Pc)	Mostly shale and siltstone, but also contains a few fine-grained clayey sandstones and some thin limestone and clay beds. The maximum thickness of the remaining part of the unit in the area is about 630 feet.	5 4-10	64 10-100	Sixty percent of the wells produce good-quality water; slight hardness in some areas; occasional iron problems.
Pocono Formation excluding the Burgoon Sandstone (Mp)	Mixed siltstone, shale, and sandstone; some claystone beds. Upper red beds ("Patton") are well exposed southeast of the Chestnut Ridge anticline. Average thickness of exposed part of unit is 360 feet.	3 1-20	40 10-500	No data available on water quality, although quality should be fair to good.
Allegheny Group excluding the Clearfield Creek Formation (Pa)	Highly variable rock types which change character with depth and lateral distance; contains shale, sandstone, siltstone, claystone, coal, and minor limestone. It is seldom necessary to drill deeper than 50 feet to hit a 5- to 15-foot sandstone. The major coal-mining activities are in this unit. The average thickness is 210 feet.	5 2-40	25 28-150	Sixty-seven percent of the wells in this unit are reported to produce water of good quality. Mining activities often cause a deterioration of the quality.

...S

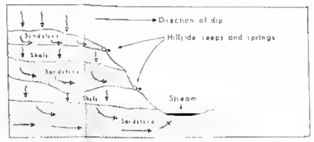
(...aggeration x 2)



STRUCTURE

The geologic structure of the DuBois area is shown by the structure contour lines, which are lines of equal elevation of selected key rock layers (or beds). The structure contour lines define the topography of the surface of these beds. In most instances in western Pennsylvania it has been observed that the overlying and underlying rock has the same general orientation. The key beds used to determine the structure are the base of the Lower Kittanning no. 3 or "B_3" coal, which was used for most of the area, the base of the Middle Kittanning or "C" coal, and the base of the Lower Freeport or "D" coal. The Middle Kittanning coal is located an average of 60 feet above the Lower Kittanning coal.

Geologic structure influences the directions and rates of groundwater flow. The typical pattern of groundwater flow consists of movement downward and outward from the high elevations (hilltop and plateau areas), and upward and inward toward the stream valleys. This flow occurs more readily when the flow direction is parallel to the bedrock dip than when the flow direction is in opposition to the dip. Thus the major component of flow is generally in the direction of the bedrock dip.



FRACTURE TRACES

Fracturing in bedrock plays a major role in the local movement and storage of groundwater. In brittle rocks such as sandstone, fractures are usually well defined, extensive vertically and laterally, and open. In the more plastic rocks, such as shale and claystone, the fractures are smaller and tighter. Unfortunately, fractures may be the only effective source of water from shales, the pore spaces are too small to be hydrologically beneficial.

The fractures in bedrock result from the natural stresses in the earth's crust. Fractures can be seen in almost every outcrop or rock exposure; however, the density of fractures is not everywhere the same. There are long, usually straight, narrow zones where fracturing is more intense than in the surrounding rock. These zones may be only a few tens of feet wide. They can often be seen on aerial photographs as narrow lines of tonal change in the soil, as aligned stream segments or as straight, narrow depressions in the land's surface. These surface expressions, which are called *fracture traces*, are thought to result from the increased susceptibility that fractured rock has to the weathering processes.

The major fracture traces in the DuBois area were mapped on aerial photographs and transposed to the map. Wells drilled on fracture traces may yield more water than similar wells drilled in the adjacent rock mass. The intersections of fracture traces may provide even more water to the wells drilled on them. The fracturing associated with fracture zones is vertical or nearly so and may extend to considerable depths. Fracture traces also may represent roof weakness in the deep-mine areas shown on the map.

DEEP MINES

In areas where deep mining of coals has taken place, the structure contours will help to determine the direction of mine-drainage flows and, when combined with the topographic contours on the map, will help locate mine-drainage discharge points. The deep-mine areas are shown on the map. These mined-out areas often affect the quality of the groundwater and the well-yield characteristics from the bedrock overlying the mines. Vertical fractures, some of which are naturally occurring and some of which result from roof collapse in the abandoned mines, drain off the water from the overlying rock mass. Wells that do not reach below the mines will tend to have irregular water levels and well yields. Bodies of groundwater overlying unflooded mines are, therefore, unreliable sources for wells. Once the mines are flooded it is possible for the water to return to its pre-mine levels. However, a return to pre-mining conditions cannot be guaranteed. In addition to the acid mine water that normally occurs in the mines, it is also possible for other pollutants to move unimpeded through the mines, making the water even more objectionable. The map does not show all of the mine entrances that may exist or the full extent of the mined-out areas.

GROUNDWATER QUALITY

Groundwater quality is a major problem in the DuBois area. The most troublesome constituents and properties are iron, sulfate, and total dissolved solids. Bacterial contamination is, for the most part, a localized problem affecting only individual wells.

Plate 1 shows the location of wells that were sampled for water-quality determinates. Those wells shown producing water of good to fair quality may have water that is slightly hard. Wells shown producing water of poor to fair quality have water that is high in iron, very hard, and/or high in total dissolved solids. A few analyses indicated moderately poor quality; the iron concentration is usually acceptable but the hardness is high. Table 2 lists chemical analyses for selected wells in the report area.

Shallow, hand-dug wells and springs that discharge from the upland areas usually produce water of good to excellent quality. Most of this water comes from sandstones that have been flushed of most of their soluble minerals by infiltrating precipitation. Water produced from shales, or sandstones overlain by shales, will tend to be more mineralized. The amount of iron or other dissolved ions depends on the form and concentration of these in the bedrock—a highly variable condition. Over much of the area good-quality water is obtained near the surface, and the deeper waters are high in iron and hardness. In some places, however, shallow zones of poor water may be cased off and better water obtained at greater depths.

All of the rock units used as aquifers in the DuBois area are known to have occurrences of both poor- and good-quality water. Some units are notorious for producing water of poor quality, such as the Kittanning and Homewood sandstones. Southwest of DuBois, deep mining may create local problems. Strip mines may have an adverse effect on the quality of water in wells located close to the stripping.

Table 2. *Chemical Analyses of Groundwater*

(Results are in milligrams per liter unless otherwise indicated.)

Well number	Date of collection	Total iron (Fe)	Total manganese (Mn)	Calcium (Ca)	Sulfate (SO_4)	Chloride (Cl)	Hardness (ppm)
			CLEARFIELD COUNTY				
Cl- 62a	7/73	6	–	–	<20	–	34.2
242	8/73	8	–	–	<20	–	17
281	9/66	4.6	–	–	124	3	194
282	7/69	.1	–	–	22	25	202
283	7/69	1.6	–	–	14	2	130
284	1/75	.21	–	–	–	–	85.5
286	3/75	14	–	–	–	–	205
287	4/73	0	–	–	2.2	1.6	82
288	4/73	.01	–	–	1.4	6	12
289	4/73	.1	–	–	2	2.4	65
290	4/73	1.2	–	–	18	1.8	110
292	4/73	16	–	–	220	2.2	200
			JEFFERSON COUNTY				
Je-209	–	.05	45	15	–	–	–
225	–	.8	–	183	–	–	–
226	7/74	2	–	–	–	–	–
246	5/70	2.76	.2	11.2	48	4	36
248	5/70	3.45	.02	8	9.0	6.5	34
271	–	–	–	–	–	–	359
295	10/64	4.2	–	–	–	8	49
297	2/69	0	0	12	4	7	46
299	11/73	7.0	–	–	–	–	34.2
300	11/73	.7	–	–	–	–	17.1
307	6/74	.04	.06	–	340	16	144

WELL YIELDS

The principal rock types in the DuBois area are sandstone and conglomerate, shale, clay, and siltstone. Coal and limestone are also present, but occur only in a very small portion of the near-surface area. These rock types may be separated into two general hydrologic groups based upon water-yielding characteristics. Sandstones and conglomerates will yield more water to wells than the fine-grained rocks such as shale, clay, and siltstone. The well yield values that were used to define these two groups were obtained from water well drillers' reports, published records, and pumping tests. Table 1 is a record of wells for the DuBois area, compiled from data on file in the Pennsylvania Geological Survey.

The well yield values were mathematically converted to indicate the yield, in gallons per minute, of each foot of rock thickness providing water to the well. The complicating effects of well construction and variable pumping rates are thus minimized. Because the overriding hydrologic consideration is the presence of sandstone, each of the geologic formations was evaluated according to the percentage of sandstone within that formation. Hydrogeologic units were determined by grouping hydrologically similar geologic formations. These have been shown on the map, and the hydrologic characteristics are given in the map explanation.

The water that bedrock supplies to water wells comes from two general types of sites within the rock mass. The most common type is the space that is found between the individual grains that make up the rock. These are called pore spaces. The usefulness of pore spaces from a hydrologic point of view is dependent on their size and the degree of interconnection between the pores, and is called the effective porosity. For sandstones in the DuBois area this will range from 3 to 14 percent of the total rock volume. For shales and other fine-grained rocks the range is more like 0.5 to 5 percent. Pore spaces in the fine-grained rocks such as shale are exceedingly small. The water contained in them is difficult to remove.

The other type of site within the bedrock that provides water to wells is the area where the fractures and partings occur. These features are found in all types of rock throughout the rock mass. Fractures tend to be more open near the surface and become tighter with depth because of the pressure of the overlying rock. Sandstones are fairly brittle rocks; therefore they permit extensive and well-defined fractures to form. The fractures in shales and claystones, on the other hand, are often smaller, tighter, and less extensive because of the plastic nature of these rocks.

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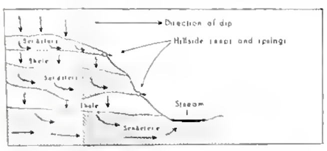

FRACTURE TRACES

Fracturing in bedrock plays a major role in the local movement and storage of groundwater. In brittle rocks such as sandstone, fractures are usually well defined, extensive vertically and laterally, and open. In the more plastic rocks, such as shale and claystone, the fractures are smaller and tighter. Unfortunately, fractures may be the only effective source of water from shales; the pore spaces are too small to be hydrologically beneficial.

The fractures in bedrock result from the natural stresses in the earth's crust. Fractures can be seen in almost every outcrop or rock exposure; however, the density of fractures is not everywhere the same. There are long, usually straight, narrow zones where fracturing is more intense than in the surrounding rock. These zones may be only a few tens of feet wide. They can often be seen on aerial photographs as narrow lines of tonal change in the soil, as aligned stream segments, or as straight, narrow depressions in the land's surface. These surface expressions, which are called *fracture traces*, are thought to result from the increased susceptibility that fractured rock has to the weathering processes.

The major fracture traces in the DuBois area were mapped on aerial photographs and transposed to the map. Wells drilled on fracture traces may yield more water than similar wells drilled in the adjacent rock mass. The intersections of fracture traces may provide even more water to the wells drilled on them. The fracturing associated with fracture zones is vertical or nearly so and may extend to considerable depths. Fracture traces also may represent roof weakness in the deep-mine areas shown on the map.

DEEP MINES

In areas where deep mining of coals has taken place, the structure contours will help to determine the direction of mine-drainage flows and, when combined with the topographic contours on the map, will help locate mine-drainage discharge points. The deep-mine areas are shown on the map. These mined-out areas often affect the quality of the groundwater and the well-yield characteristics from the bedrock overlying the mines. Vertical fractures, some of which are naturally occurring and some of which result from roof collapse in the abandoned mines, drain off the water from the overlying rock mass. Wells that do not reach below the mines will tend to have irregular water levels and well yields. Bodies of groundwater overlying unflooded mines are, therefore, unreliable sources for wells. Once the mines are flooded it is possible for the water to return to its pre-mine levels. However, a return to pre-mining conditions cannot be guaranteed. In addition to the acid mine water that normally occurs in the mines, it is also possible for other pollutants to move unimpeded through the mines, making the water even more objectionable. The map does not show all of the mine entrances that may exist or the full extent of the mined-out areas.

GROUNDWATER QUALITY

Groundwater quality is a major problem in the DuBois area. The most troublesome constituents and properties are iron, sulfate, and total dissolved solids. Bacterial contamination is, for the most part, a localized problem affecting only individual wells.

Plate 1 shows the location of wells that were sampled for water-quality determinates. Those wells shown producing water of good to fair quality may have water that is slightly hard. Wells shown producing water of poor to fair quality have water that is high in iron, very hard, and/or high in total dissolved solids. A few analyses indicated moderately poor quality; the iron concentration is usually acceptable but the hardness is high. Table 2 lists chemical analyses for selected wells in the report area.

Shallow, hand-dug wells and springs that discharge from the upland areas usually produce water of good to excellent quality. Most of this water comes from sandstones that have been flushed of most of the soluble minerals by infiltrating precipitation. Water produced from shales, or sandstones overlain by shales, will tend to be more mineralized. The amount of iron or other dissolved ions depends on the form and concentration of these in the bedrock—a highly variable condition. Over much of the area good-quality water is obtained near the surface, and the deeper waters are high in iron and hardness. In some places, however, shallow zones of poor water may be cased off and better water obtained at greater depths.

All of the rock units used as aquifers in the DuBois area are known to have occurrences of both poor- and good-quality water. Some units are notorious for producing water of poor quality, such as the Kittanning and Homewood sandstones. Southwest of DuBois, deep mining may create local problems. Strip mines may have an adverse effect on the quality of water in wells located close to the stripping.

Table 2. Chemical Analyses of Groundwater

(Results are in milligrams per liter unless otherwise indicated.)

Well number	Date of collection	Total iron (Fe)	Total manganese (Mn)	Calcium (Ca)	Sulfate (SO_4)	Chloride (Cl)	Hardness (ppm)
CLEARFIELD COUNTY							
Cl-62a	7/73	6			<20	–	34.2
242	8/75	8			<20		17
281	9/65	4.6			124	3	104
282	7/69	1			44	25	202
283	7/69	1.0			14	2	130
284	1/75	.1					85.5
286	3/75	15					205
287	4/73	[illegible]			2.2	1.6	82
288	8/73	1			1.4	6	12
289	8/73				2	2.1	65
290	4/73	[illegible]			18	1.8	110
292	1/73	[illegible]			220	2.2	200
JEFFERSON COUNTY							
Je-209		5	45	15			
223		[illegible]		183	–		–
228	7/74	2	–			–	
246	3/76	2.6	2	11.2	48	4	36
258	5/70	1.18	.02	8	8.0	6.5	34
271			–		–	–	359
295	10/61	4.2				8	49
297	7/69		0	12	4	–	16
299	[illegible]						31.2
301	[illegible]		–				17.5
[illegible]	[illegible]	5	[illegible]		311	[illegible]	144

[illegible]											14.3	7/73	–	–	–	–
36	4101-7838	George Anderson			Mph	–	25	–	–	–	14.08	7/73	–	–	–	–
37	4101-7838	Pictin Lubbe	–		Mph	–	18	–	–	–	7.86	7/73	–	–	–	–
38	4102-7838				Pcv		–	–	–	–	20.0	7/73	–	–	–	–
39	4102-7838	Anderson Sportsmen's Club			Pcc	–	–	–	–	–	9.76	7/73	–	–	–	–
40	4102-7839	Harold Miller			Mph	–	18	–	–	–	10.26	7/73	–	–	–	–
41	4102-7839	Edward Gelnett	F. W. Weber		Mph	–	33	7	6	–	.76	7/73	–	–	–	–
42	4102-7839	John Shobert			Mph	–	10	–	–	–	2.9	7/73	–	–	–	–
43	4102-7839	do.			Mph	–	27	–	–	–	15.0	7/73	–	–	–	–
44	4101-7839	Mrs. Thomas Hehler		–	Pcv	–	29	–	–	–	23.9	7/73	–	–	–	–
45	4101-7839	Luther Hartsfield		–	Pcv	–	20	–	–	–	16.0	7/73	–	–	–	–
46	4101-7839	Mrs. Franklin		–	Pcv	–	22	–	–	–	14.25	7/73	–	–	–	–
47	4101-7839	Charles Haag		–	Pcc	–	–	–	–	–	6.9	7/73	–	–	–	–
48	4101-7810	Lerenbhum		–	Pcc	–		–	–	–	3.0	7/73	–	–	–	–
49	4100-7810	Vern Forwalth		–	Pcc	–	–	–	–	–	0.4	7/73	–	–	–	–
50	4100-7810	–		–	Pa	–	–	–	–	–	14.75	7/73	–	–	–	–
51	4100-7810	–		–	Pa	–	–	–	–	–	33.5	7/73	–	–	–	–
53	4100-7841	John Kear	Forsythe	–	Pc	–	–	–	6	–	61.2	7/73	–	–	–	–
54a	4100-7841	Shaffer Estate	–	–	–	–	26	–	–	–	12.25	7/73	–	–	–	–
54b	4100-7841	do.		–	–	–	28	–	–	–	14.0	7/73	–	–	–	–
55	4100-7841	Leland Fred Shaffer	Forsythe	–	Pa	–	100	20	6	80	45.7	–	4	–	–	–
56	4101-7842	Robert Spencer	–	–	Pa	–	10	–	–	–	3.0	7/73	–	–	–	–
57	4101-7840	Charles Lee	Delp	–	Mph	–	100	–	6	–	10.3	7/73	1	–	–	–
59a	4101-7843	Olan Landon		–	Pcc	–	100	32	0	–	40.00	–	–	–	–	–
59b	4101-7843	do.		–	–	–	81	20	0	–	35.00	–	–	–	–	–
59c	4101-7840	do.		–	–	–	25	–	–	–	13.4	7/73	–	–	–	–
60	4100-7841		–	–	Pa	–	24	–	–	–	12.5	7/73	–	–	–	–
62a	4101-7844	James Donahue	–	–	Pcc	–	28	–	–	–	17.0	7/73	–	–	–	–
62b	4101-7844	do.	Lindemuth	1970	Pcc	–	43	16	0	–	14.1	7/73	21.4	6	.76	6.2
64	4103-7843	Don Witheright	Forsythe	1963	Pc	–	85	–	–	–	51.8(?)	7/73	8-9	–	–	–
65	4100-7830	James Macey	do.	1972	Pcv	–	100	25	6	98	–	–	5	–	–	–
66	4100-7830	James Hall	do.	1972	Pcv	–	80	25	6	78	–	–	5	–	–	–
67	4103-7818	Michael Hall	do.	–	Pcv	–	120	25	6	38	–	–	10-12	–	–	–
68	4103-7812	John Gray	–	–	Pa	–	14.3	–	–	–	7.8	7/73	–	–	–	–
70	4104-7812		Crytzer	–	Pc	–	48	–	6	30	–	–	1	–	–	–
71	4101-7811			–	Pcc	–	11.5	–	–	–	4.5	7/73	–	–	–	–
72	4105-7811	Clyde Miller	Forsythe	–	Pc	–	86	32	6	34	27.8	7/73	20	–	–	–
73	4100-7814	L. A. Kessler		–	Pc	–	80	–	6	–	13.5	7/73	–	–	–	–
74	4105-7811	Mrs. Walter Dunlap		–	Pclm	–	21	–	–	–	4.1	7/73	–	–	–	–
76	4105-7810	Don Wayland		–	Pcc	–	9.5	–	–	–	0.4	7/73	–	–	–	–
78	4104-7830	Sunset Lake Campground	Union	–	–	–	120	–	6	40	–	–	–	–	–	–
79	4101-7838	Berie Maple Center	Forsythe	–	Mph	–	125	–	6	75	–	–	–	–	–	–
81	4105-7878	V. C. Shaffer		–	Pcv	–	–	–	–	–	6.0	7/73	–	–	–	–
83	4106-7814	Phyllis Sterling		–	Pclm	–	21	–	–	–	10.0	7/73	–	–	–	–
84	4106-7838	Chet Shaffer	–	–	Qal	–	16.9	–	–	–	4.3	7/73	–	–	–	–
85	4106-7838	Ronald Reed		–	Pclm	–	9.6	–	–	–	5.0	7/73	–	–	–	–
86	4106-7816			–	Pcv	–	160	–	0	–	131.8	7/73	–	–	–	–
87	4106-7819	Al Oliver and Son	Forsythe	1957	Pclm	–	50	–	6	–	28.0	7/73	–	–	–	–
88	4104-7814	Bernard Hallaker	do.	1958	Pclm	–	135	30	–	18, 60, 120	–	–	7	–	–	–
89	4104-7838	George Postlethwait		–	Mpb	–	27.0	–	–	–	11.9	7/73	–	–	–	–
91	4101-7810	John Bambridge	–	–	Pcc	–	25.7	–	–	–	14.0	7/73	–	–	–	–
92	4104-7844	Arthur Gerhart		–	–	–	14	–	–	–	7.2	7/73	–	–	–	–
93	4108-7812			–	–	–	79	–	6	–	35.6	8/73	–	–	–	–
94	4108-7841	Calvin Dixon	F. W. Weber	–	–	–	110(?)	15	6	–	21.6	8/73	–	–	–	–
98	4114-7832	Don Georgino	Forsythe	1969	–	–	168	30	6	–	–	–	–	–	–	–
101	4114-7831	Shawmut Mines		–	–	–	–	–	6	–	32.9	8/73	–	–	–	–
103	4101-7845	James Bonsall		–	–	–	18	–	–	–	14.8	8/73	–	–	–	–
104	4101-7816	Dan Bonsall	–	–	–	–	11	–	–	–	4.4	8/73	–	–	–	–
105	4100-7847	Robert Lee	–	–	Pc	–	21.8	–	–	–	10.1	8/73	–	–	–	–
106	4100-7848	William Mills	Dinger Bros.	1970	–	–	222	3	6	76, 200	13.0	8/73	5-6	–	–	–
124	4106-7848	Tim Robertson	Forsythe	1972	–	–	200	170	6	180	–	–	10	–	–	–
127	4104-7848	Raymond Shaffer	–	–	Pc	–	–	–	6	–	39.2	8/73	–	–	–	–
128	4106-7817	Gary Pfall	–	–	Pc	–	–	–	–	–	62.1	8/73	–	–	–	–
129	4104-7815	James Gray	–	–	Pc	–	17.4	–	–	–	9.6	8/73	–	–	–	–
130	4105-7841	John Fuller	F. W. Weber	1952	Pc	–	110	20	6	60, 94	–	–	–	–	–	–
132	4105-7815	Josephine Carlson	–	–	Pt	–	20	–	–	–	16.3	8/73	–	–	–	–
134	4112-7838		–	–	–	–	–	–	–	–	14.0	9/73	–	–	–	–
136	4109-7839	William Kennedy	–	–	Pc	–	85	–	6	–	50.8	9/73	–	–	–	–
137	4107-7878	Dale Heber	–	1970	Pa	–	225	27	6	190	–	–	15	–	–	–
138	4112-7810	R. L. Close	–	–	–	–	47.2	–	6	–	9.9	9/73	–	–	–	–
139	4108-7841	M. L. Stewart	–	–	Qal	–	13.0	–	–	–	6.0	9/73	–	–	–	–
140	4109-7810	Durden Chilcester	Forsythe	1972	Pc	sh	235	23	6	60, 140, 215	–	–	12	–	–	–
142	4112-7839	George Cesana	do.	–	–	–	40	30	4	20	–	–	–	–	–	–
143	4111-7838	Dale Fowler	–	–	Pc	–	176	–	6	165	114.5	9/73	3-5	–	–	–
145	4107-7843	Henry Bailey	Crytzer	–	Pc	–	64	–	–	–	15.1	9/73	–	–	–	–
147	4105-7811	Richard Kuntz	–	–	Pc	–	86	80(?)	6	–	22.6	9/73	–	–	–	–
148	4109-7840	Lahana Burns	–	–	–	–	69(?)	–	6	–	30.5	9/73	–	–	–	–
149	4109-7841	Otto Edinger	–	–	Pc	–	18	–	–	–	13.7	9/73	–	–	–	–
151	4111-7811	Charles Young	–	–	Pa	–	–	–	–	–	13.9	9/73	–	–	–	–
152	4112-7839	John Mulek	–	–	Pc	–	20(?)	–	–	–	16.2	9/73	–	–	–	–
161	4111-7839	Franklin Tyler, Jr.	Forsythe	1973	Pc	–	245	–	–	–	110.5	10/73	–	–	–	–
167	4107-7832	Pa. Bureau of Forestry	Crytzer	1964	–	–	152	20	6	100, 150	10.2	8/73	40	–	–	–
169	4112-7811	Lady Jane Collieries Inc.	Delp	1972	–	–	606	25	10	168; 300	–	–	2	–	–	–
176	4114-7833	Deruman Gas & Oil Co.	–	–	–	–	149	–	–	–	112.2	9/73	–	–	–	–
178	4106-7833	Camp 9C 244	–	–	–	–	8	–	–	–	5.0	9/73	–	–	–	–
180	4106-7832	Twin Oaks Camp 9C-31	–	–	–	–	–	–	–	–	17.2	9/73	–	–	–	–
181	4107-7839	Emory Miller	Forsythe	–	–	–	150	–	–	–	63.4	9/73	–	–	–	–
183	4107-7837	–		–	–	–	–	–	–	–	8.6	9/73	–	–	–	–
211	4108-7845	Dr. W. Lundgren	Crytzer	1966	Pc	ss	113	–	6	–	–	–	15	0	2	–
233	4111-7846	Mrs. Clark	Lindemuth	1973	Pcv	sh	106	21	6	50, 90	–	–	10	30	.5	–
234	4111-7846	Kauk Floors	Forsythe	1972	–	–	120	21	6	110	–	–	10	–	–	–
235	4111-7846	Gotham Bros.	do.	1972	–	ss	140	21	6	120	–	–	10	–	–	–
242	4101-7844	Hartzell	–	–	Pcc	–	109	–	–	–	16.76	8/75	–	–	–	6.1
243	4114-7834	Dale Crawford	Crytzer	1974	Pc	ss	62	14	0	50	–	–	20	0	2	–
244	4114-7834	Dennis Crawford	do.	1975	Pc	ss	51	15	6	40	–	–	20	0	2	–
263	4111-7838	Clyde Keller	Webber	–	Pc	–	150	–	–	–	111.0	10/73	–	–	–	–
264	4108-7815	Denlon Const (?)	Crytzer	1966	Pa	ss	295	35	8	105; 250	–	–	45	0	4	–
265	4111-7832	Pa. State Univ.	Brooks	1969	Pcc	–	125	55	8	80; 105	–	–	60	1.5	48	7.5
281	4103-7842	Luthersburg School	Tyger	1965	Pa	–	260	22	6	138, 154, 212, 260	78.75	9/65	11	1	1.25	6.9
282	4102-7846	Helvetia Water Co.	Forsythe	1961	Pa	ss	230	20	8	–	105	2/75	28	27	4	–
283	4102-7846	do.	–	1948	Pa	ss	183	50	6	–	38	5/64	23	18	4	–
284	4106-7845	Highland High School	Pa. Drilling	1975	Pa	ss	292	–	–	88, 125; 182	30	1/75	2	–	–	–
285	4112-7838	Pa. Core Hole #1	Harvey	1969	–	–	716	–	–	–	55	4/73	–	–	–	–
286	4103-7843	DuBois Area School	Pa. Drilling	1975	Pa	–	80	–	–	–	50.2	2/75	–	–	–	–
287	4111-7843	Treasure Lake	Layne	1970	Pep	–	360	31	10	36, 130, 159, 174	Flowing	11/70	205	102	48	–
288	4111-7842	do.	do.	1970	Pep	–	290	22	6	–	37.2	12/70	140	11(?)	12	–
289	4111-7842	do.	do.	1970	Mp	–	410	24	10	20; 98; 111; 245	20	12/70	250	56	48	–
290	4110-7843	do.	do.	1970	Mpb(?)	–	440	26	6	25, 41, 60, 202	15	9/70	200	–	12	–
291	4109-7842	do.	do.	1970	Pc	–	265	20	6	50; 85, 120	Flowing	8/70	80	27	45	–
292	4109-7843	do.	do.	1970	Pc	–	265	14	8	–	Flowing	8/70	132	50	48	–
ELK COUNTY																
Ek-97	4114-7831	Bernice Washkow	–	–	–	–	–	–	–	–	14.76	8/73	–	–	–	–
155	4114-7843	Sam Siple	–	–	Pa	–	21	–	–	–	10.0	9/73	–	–	–	–
157	4113-7844	John Duttry	–	–	Pa	–	19	–	–	–	9.9	10/73	–	–	–	–
158a	4114-7842	Loren Coleman	–	–	Pcc	–	[illegible]	–	–	–	5.0	10/73	–	–	–	–
158b	4114-7842	do.	–	–	Pp	–	72	–	–	–	13.3	10/73	–	–	–	–
177	4114-7838	Carolyn Hoover	–	–	–	–	106	–	–	–	–	–	1.5	15	1	–
263	4114-7842	Brockway Bor	–	1969	Mp	–	120	–	–	72; 86, 98	–	–	500(?)	–	–	–
JEFFERSON COUNTY																
Je-108	4102-7851	Jim Doulhit	Forsythe	1970	Pc	–	160	–	–	–	122.2	8/73	–	–	–	–
109	4101-7850	Charles Kurtz	Dinger Bros.	1973	Pc	–	85	21	6	70	42.7	8/73	5	–	–	–
110	4100-7849	Gordon Knarr	–	–	Pc	–	125	25(?)	6	–	33.9	8/73	–	–	–	–
111	4101-7848	P. E. Syphrit	–	–	Pc	–	65(?)	–	–	–	32.2	8/73	–	–	–	–
112	4105-7851	Mike Maxim, Sr.	–	–	Pa	–	32	–	–	–	19.9	8/73	–	–	–	–
113	4104-7850	S. M. Lyles	–	–	–	–	25	–	–	–	5.0	8/73	–	–	–	–
114	4103-7850	John Wascovich	–	–	–	–	25	–	–	–	18.0	8/73	–	–	–	–
116	4101-7852	Leslie Piffer	Morris Smith	1954	Pc	–	49	26	–	–	18.5	8/73	–	–	–	–
120	4105-7851	Mrs. Pearl Rea	–	–	–	–	–	–	–	–	5.9	8/73	–	–	–	–
121	4104-7851	Charles Dye	–	–	Pa	–	75	–	–	–	5.6	8/73	–	–	–	–
122	4105-7850	Paul Sylus	–	–	Pa	–	12.8	–	–	–	8.0	8/73	–	–	–	–
125	4105-7848	Clyde Hannah	–	–	Pa	–	16.8	–	–	–	4.6	8/73	–	–	–	–
126	4105-7848	Howard Adamson	–	–	Pa	–	37(?)	–	–	–	21.4	3/73	–	–	–	–
133	4107-7849	L. C. Tapper	Crytzer	1965(?)	Pa	–	50	45	8	–	14.7	9/73	–	–	–	–
156	4113-7844	–	–	–	Pp	–	80	–	–	–	9.9	10/73	30	–	–	–
160a	4108-7850	H. W. Anthony	Forsythe	–	Pa	–	184	52	6	–	73.9	10/73	–	–	–	–
160b	4108-7850	do.	–	–	Pa	–	92	19	6	–	48.2	10/73	–	–	–	–
162	4108-7850	Spoor	–	–	Pa	–	14	–	–	–	10.2	10/73	–	–	–	–
163	4109-7851	Angelo Panali	–	–	Pcc	–	13	–	–	–	5.0	10/73	–	–	–	–
164	4109-7851	–	–	–	Pcc	–	47	–	–	–	17.0	10/73	–	–	–	–
165	4110-7850	Gerald Taft	–	–	–	–	45	–	–	–	11.6	10/73	–	–	–	–
185	4103-7852	John Biggie	–	–	–	–	90(?)	–	6	–	49.7	6/74	15(?)	–	–	–
186	4104-7853	Akens	–	–	–	–	80(?)	–	–	40	–	–	20	–	–	–
186	4103-7854	–	–	–	–	–	27	–	–	–	6.5	6/74	–	–	–	–
190	4102-7856	Robert Heltzentaler	Crytzer	1973	–	–	175	–	–	170	–	–	10	–	–	–
191	4104-7854	Phyllis Roush	–	–	–	–	24	–	–	–	15.8	6/74	–	–	–	–
192	4103-7853	Harvey DeBerry	Crytzer	1974	–	–	150	20	6	100	96.0	6/74	15	–	–	–
193	4101-7854	George Sukkala	do.	1969	Pa	–	177	27	6	157	–	–	30	–	–	–
194	4101-7854	–	do.	1969	–	–	190	–	6	60	109.2	4/74	15	–	–	–
195	4102-7852	R. L. Butler	do.	1973	–	–	385	–	–	200; 355	228.7	6/74	15	–	–	–
196	4101-7857	Jim Hixson	–	–	–	–	40	–	–	35	–	–	10	–	–	–
197	4104-7855	Dave Snyder	Forsythe	1972	–	–	60	–	6	30	34.9	6/74	10	–	–	–
198	4104-7856	Theo Horner	–	1966	–	–	75	–	–	30; 75	–	–	10-15	–	–	–
200	4107-7858	J. F. Traulman	Rokey	1952	–	–	47	20	6	45	–	–	5	–	–	–
201	4104-7859	Paul Plyer	–	–	–	–	28	–	–	15	18.8	6/74	5-10	–	–	–
202	4104-7850	do.	–	–	–	–	85	–	6	40(?)	–	–	2	–	–	–
203	1104-7900	G. M. Hetta	Dinger Bros.	1971	–	–	220	21	6	200	–	–	10	–	–	–
204	4104-7859	Arden Johles	–	–	–	–	40	21	6	30	28.2	6/74	3-4	–	–	–
205	4103-7858	Robert Uplinger	Dinger Bros.	1968	–	–	120	22	6	75; 416	–	–	5-10	–	–	–
206	4106-7853	B. Vivian	–	–	–	–	45	20	6	15	–	–	90	–	–	7.6
209	4100-7859	L. Fisher	S & W Drilling	1972	–	–	130	130	6	40	–	–	10	–	–	–
210	4101-7856	Bob Waltman	Miller Pump	–	–	–	196	–	6	–	–	–	5	–	–	–
213	4113-7845	R. McHenry	Forsythe	1968	–	–	245	60	6	89; 245	–	–	5-10	–	–	–
217	4113-7850	Hiram Bundy	–	–	–	–	100	–	6	–	–	–	10+	–	–	–
218	4113-7852	Rodger Lindemuth	Lindemuth	1971	–	–	18	21	6	12	–	–	10+	–	–	–
219	4114-7850	Robert Lindemuth	do.	–	–	–	25	25	6	14	–	–	5+	–	–	–
220	4114-7852	William Bovard	Crytzer	–	–	–	50(?)	–	–	–	–	–	5+	–	–	–
222	4113-7847	Everett Gustafson	–	–	–	–	280	21	6	118; 140	–	–	5-10	–	–	–
223	4113-7849	Sam Gallo	Lindemuth	1973	–	–	140	20	6	–	–	–	5+	–	–	–
224	4112-7851	Mel Jamison	do.	1971	–	–	200+	21	–	–	–	–	15	–	–	7
225	4111-7851	Todd Kalgren	Crytzer	1965	–	–	75	20	–	–	–	–	10+	–	–	–
226	4111-7819	Herb Stevenson	Forsythe	–	–	–	100+	–	6	–	48.1	7/74	5-10	–	–	6.7
227	4113-7859	Mrs. Shaler	Crytzer	1967	–	–	121	50	6	50	–	–	5-10	–	–	–
228	4112-7859	H. C. Boozer	Delp	1971	–	ss	110	27	6	–	–	–	5-10	–	–	–
229	4112-7850	A. Van Norman	Forsythe	1960	–	–	30	–	–	–	–	–	10	–	–	–
231	4114-7854	William Brosius	Delp	1971	–	–	52	20	6	10; 45	–	–	10+	10	.5	–
232	4113-7848	Sam Gallo	Lindemuth	1973	Pa	ss	140	20	6	125	–	–	7	10	.5	–
236	4112-7847	Dick Smith	do.	1973	Pa	sh	60	30	6	70	–	–	10	–	–	–
237	4112-7854	Dick Quinn	Delp	1973	–	–	55	22	6	–	–	–	–	–	–	–
238	4113-7852	Melvin Lindemuth	Lindemuth	1974	–	–	40	34	6	35	–	–	8	–	–	–
239	4110-7852	Kenneth Tudor	do.	1972	Pa	ss	40	22	6	28	34.18	10/75	35	8.5	48	6.6
246	4108-7857	Pa. Dept. of Transportation	Moody	1970	Mpb	ss	298	170	6	–	–	–	8	30	2	–
247	4107-7852	Harold Raybuck	Crytzer	1975	Pcc	sh	70	14	6	60	–	–	35	5	48	6.6
248	4108-7856	Pa. Dept. of Transportation	Moody	1970	Pep	ss	295	85	6	79, 220, 250	–	–	20	15	2	–
249	4110-7850	John Tonach	Crytzer	1975	Pa	sh	50	28	6	34; 40	–	–	15	–	–	–
251	4109-7850	North Star Construction	do.	1975	Pa	sh	60	23	6	45	–	–	5	76	.5	–
252	4108-7857	Robert Emery	Miller	1974	Pcc	ss	126	18	6	45	58	10/75	40	0	4	–
254	4111-7858	Bill Egler	Crytzer	1975	Pcv	ss	102	14	6	90	–	–	10+	0	.5	–
255	4112-7857	Harold Lockwood	Lindemuth	1974	Pcc	ss	120	20	6	50, 100	–	–	40	10	4	–
256	4109-7849	Francis Collins	Crytzer	1975	Pcc	ss	33	16	6	25	–	–	30	0	3	–
257	4109-7849	Kendall Perrin	do.	1973	Pcc	ss	30	15	6	25	–	–	20	0	2	–
258	4108-7858	Ray Dinger	do.	1973	Pcv	ss	138	25	6	130	–	–	20	0	2	–
259	4106-7852	Richard Gibson	do.	1973	Pa	sh	78	25	6	70	–	–	7	–	–	–
260	4105-7850	Fred Alderton	Lindemuth	–	Pa	sh	58	21	6	–	–	–	10+	–	–	–
261	4105-7851	Larry Schuckers	do.	1974	Pa	sh	50	27	6	40	–	–	30	0	3	–
262	4102-7854	Dominick Torrell	Crytzer	1973	Pa	ss	200	20	6	186	–	–	5-6	–	–	–
263	4102-7857	M. L. Rhodes	Dinger Bros.	1968	–	–	190	22	6	174	–	–	30	5	3	–
264	4114-7840	Charles Murray	Crytzer	1967	Pa	sh	84	34	6	78	–	–	15	0	2	–
265	4114-7819	Clyde Salendia	do.	1967	Pa	sh	100	42	6	–	–	–	10	–	–	–
267	4114-7845	Harry Stineberg	Lindemuth	1969	Qal	–	35	–	–	35	–	–	30	–	–	–
269	4112-7846	Denny Brubaker	Crytzer	1967	–	–	75	–	–	68	–	–	10	0	3	–
270	4112-7846	Joseph Donati	do.	1968	Pcc	sh	77	32	6	68	23.7	–	9.5	6.3	–	–
271	4106-7857	U.S. Geol. Survey	Miller	1967	Pa	–	101	37	–	30, 39; 45	–	–	40	0	3	–
272	4106-7857	Womeldorf, Inc.	Crytzer	1967	Pcv	ss	190	63	8	41; 75; 140	–	–	5	35	3	–
273	4102-7854	Tony Viela	do.	1967	Pa	–	95	38	6	82	–	–	30	0	3	–
274	4109-7851	J. H. Bussard	do.	1970	Pcc	sh	38	33	6	35	–	–	20	0	2	–
275	4109-7848	John Daugherty	Crytzer	1970	Pcc	ss	31	15	6	29	–	–	4	46	2	–
276	4110-7817	J. A. Gaffney	do.	1969	Mpb	m	85	35	6	60; 80	–	–	–	–	–	–
277	4103-7859	Calvin Uplinger	Dinger Bros.	1971	–	–	145	60	6	85; 125	–	–	30	0	3	–
278	4114-7819	Paul Smith	Crytzer	1970	Plr	–	154	33	6	–	–	–	20	0	3	–
279	4111-7817	Jack Hallstell	do.	1969	Pml	ss	95	22	6	80	–	–	6-8	–	–	–
280	4109-7847	Fred Duffey	Dinger Bros.	1970	–	–	142	22	–	54; 100; 135	45	–	20	–	–	–
295	4114-7853	Richard McKay	–	1964	Pa	–	64	43	6	–	10	1/62	21	50	.25	–
296	4114-7847	Brockway Glass	–	1940	Pml	–	100	–	8	–	Flowing	4/70	–	–	–	6.2
297	4113-7842	Brockway Bor	–	–	Mp	–	125	43	8	–	40	9/73	20	3	1	–
298	4112-7859	Bill Gallwath		1973	Pml	–	65	28	6	–	6	11/73	40	10	.5	–
299	4106-7857	Robert Betts		1972	Pcc	ss	42	10	6	–	9	11/73	5	21	–	–
300	4106-7848	Richard Zimmerman	–	1971	Pms	–	65	20	6	60	28	–	30	10	4	–
301	4110-7851	Blake Cooper	Crytzer	1949	Pms	–	63	27	6	35; 55	40	–	5	40	2	–
302	4108-7848	Frederick Smith	do.	1961	Pms	–	60	23	6	60	71	–	3	75	4	–
303	4108-7849	John Fernasyi	do.	1961	Pms	–	146	14	6	71; 135	10	–	40	0	2	–
304	4110-7852	Bill Cooper	do.	1961	Pml	–	48	35	–	47	62	–	10	0	2	–
305	4110-7853	Ford Cooper	do.	1959	Pms	–	115	–	6	–	45	–	3	51	4	–
306	4108-7848	Oscar Copenhaver	do.	1949	Pms	–	96	11	6	51; 70	142	6/74	17	46	46	7.7
307	4100-7850	Stump Creek Water	Forsythe	–	Pc	–	278	20	6	–						